RECYCLING AND SANITATION AT DUKE UNIVERSITY: REPORT OF EVALUATION OF DUKE UNIVERSITY'S LONG TERM SOLID WASTE MANAGEMENT ALTERNATIVES

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January 31, 1994

Duke University
Material Support Department
Box 90493
Durham, North Carolina 27708

Attention: Mr. Paul Brummett

Subject: **RECYCLING AND SANITATION AT DUKE UNIVERSITY; REPORT OF EVALUATION OF DUKE UNIVERSITY'S LONG TERM SOLID WASTE MANAGEMENT ALTERNATIVES LAW ENGINEERING JOB NO.: 475-09005-01**

Dear Mr. Brummett:

During the past 6 months, Law Engineering in conjunction with Duke University staff, has undertaken a project to study Duke University's solid waste management system which includes the sanitation and recycling operations. This report is the culmination of our efforts which were authorized by your acceptance of our Proposal No. RAL47593-00982 dated May 27, 1993.

We have developed a format for presenting and evaluating solid waste management/financial information from a variety of sources at Duke. We believe the conclusions generated can help Duke become a leader among colleges and universities in managing their solid waste stream. Our conclusions, if implemented, would require commitment from all segments of the university (managers, employees, professors, and students).

This project could have been difficult if not for the efforts and cooperation of many persons. Most of those are listed in Section I of the report. There is however, one person who deserves special recognition. Ms. Stephanie Finn has worked very hard in providing us the information necessary to progress through the tasking of this project. She's also a co-author of this report. A large part of her work has been done away from the office and on her own time. We have been very fortunate to have had her as a partner in this endeavor. Duke now has someone on staff who has accumulated a great deal of broadly based knowledge regarding Duke's solid waste management practices. Ms. Finn should also be commended on her efforts at developing Duke Recycles. She began with nothing and has developed a very cost competitive program.

In this report we have attempted to be thorough and accurate, and there have been numerous revisions to our data, as more up to date information became available. The spread sheets generated can be used and updated into the future to serve as management tools.

Thank you for the opportunity to be of service to Duke University. If you have any questions regarding this project, please contact us.

Sincerely,

LAW COMPANIES, INC.

Francis R. (Randy) Bowen
Senior Solid Waste Specialist

Jimmy N. Smith, P.E.
Vice President
Principal

FRB/JNS/klc/pjp

EXECUTIVE SUMMARY

In this project we have evaluated four detailed solid waste management models comparing the seven year economic impact of each. Scenario One assumes no changes in operations. Scenario Two requires increased cooperation among different departments at Duke. Scenario Three includes a management structure reorganization. Scenario Four eliminates recycling as a means of solid waste management. We recommend that Scenario Three be implemented as soon as practicable.

Our reasons for recommending this option to Duke University are:

- Social/political
- Best management practice for the entire waste stream
- Economic
- Potential for Duke to be a leader among universities in dealing with the solid waste issues.

In comparing Scenarios One (Status Quo) and Three (Structural Reorganization), under the most favorable conditions for waste reduction (moderately increasing tipping fees, maximum values for recyclables), and assuming a two year implementation period, the net annual savings to Duke in FY 95-96 would be approximately $295,000. In FY 96-97, when maximum percentage reduction of the waste stream occurs, those savings would be approximately $500,000 and would maintain at about this level to and beyond FY 1999-2000. This is demonstrated by chart #1 on page iii, and the table on page ii.

In comparing Scenarios One and Three under the least favorable conditions (low prices for recyclables, slowly increasing tip fees), the net annual savings after the process of implementation is approximately $124,000/yr for FY 95-96. In FY 96-97 those savings are approximately $226,000, and would be maintained at about this level to and beyond the FY 1999-2000. This is demonstrated by chart #2 on page iv and the table on page ii.

The data we have evaluated supports this recommendation although there are variables that we cannot predict which may alter some of the figures. We believe the most realistic estimate for savings occurs somewhere between the most and least favorable conditions.

In further support of this conclusion we have used conservative rather than aggressive estimates throughout this document whenever there was an option. It is quite possible that tipping fees for the year 2000 may be greater than the $69 level

estimated in the moderate scenario. In this case the cost savings would be even more dramatic.

Implementation of Scenario Three would be an aggressive program. We have estimated the cost and equipment requirements for doing so in Figure 18 on Page 36. These implementation costs are estimations based on the establishment of a composting program and a change in the method by which your solid wastes are handled.

To briefly look at where implementation of Scenario Three would break even under the most and least favorable conditions we have generated the table below.

	MOST FAVORABLE NET COST/BENEFIT	IMPLEMENTATION/NET SAVINGS/LOSS	LEAST FAVORABLE NET COST/BENEFIT
FY 93-94 FY 93-94	-250,000 -51,935	IMPLEMENTATION NET SAVINGS/LOSS	-250,000 -45,960
FY 94-95 FY 94-95	-250,000 -35,589	IMPLEMENTATION NET SAVINGS/LOSS	-250,000 -68,041
FY 95-96	+295,480	NET SAVINGS	+124,010
FY 96-97	*+506,597	NET SAVINGS	+226,499
FY 97-98	+531,444	*NET SAVINGS	+254,864
FY 98-99	+544,621	NET SAVINGS	*+254,274
FY 99-00	+563,068	NET SAVINGS	+269,140
PROJECTED 7 YEAR SAVINGS	1,853,686	NET SAVINGS	514,786

It must be noted that if implementation is done more quickly than 2 years, cost savings will occur more quickly.

The long term potential cost savings of comparing a new waste management system to one which maintains operations in the status quo are significant. Successful implementation will be a challenge to the Duke University Community, but potentially quite rewarding.

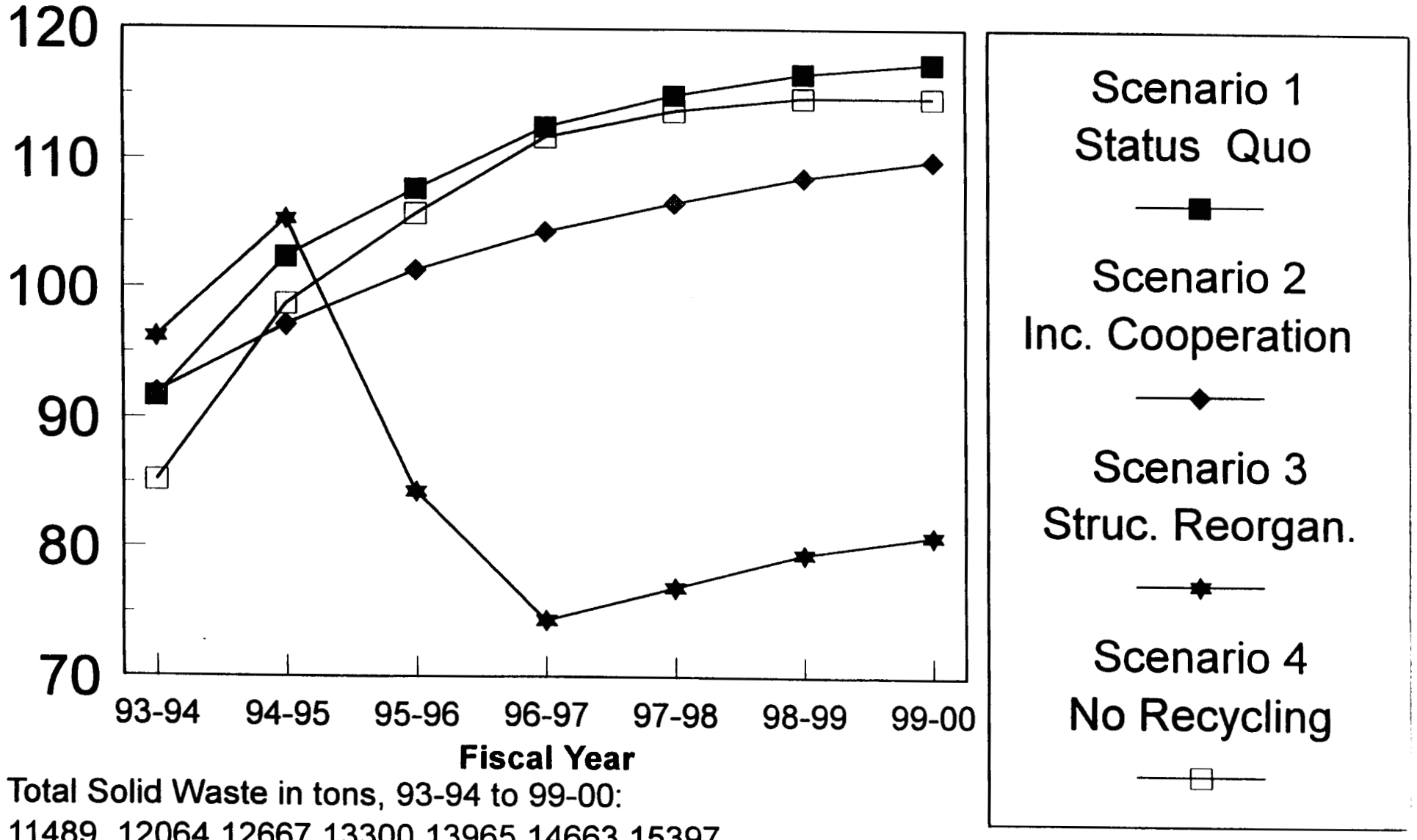
*Breakeven occurs under the most favorable conditions for waste reduction at some point in FY 96-97. Under the least favorable conditions breakeven occurs at some point in FY 98-99. In accordance with our previous statement, that savings would occur somewhere between our most and least favorable conditions, it is realistic to state that actual breakeven would occur during FY 97-98.

Chart 1

A Comparison of Scenarios 1-4

(High-Level Pricing, Moderately Increasing Tipping Fees)

$/ton Cost of All Solid Waste Management



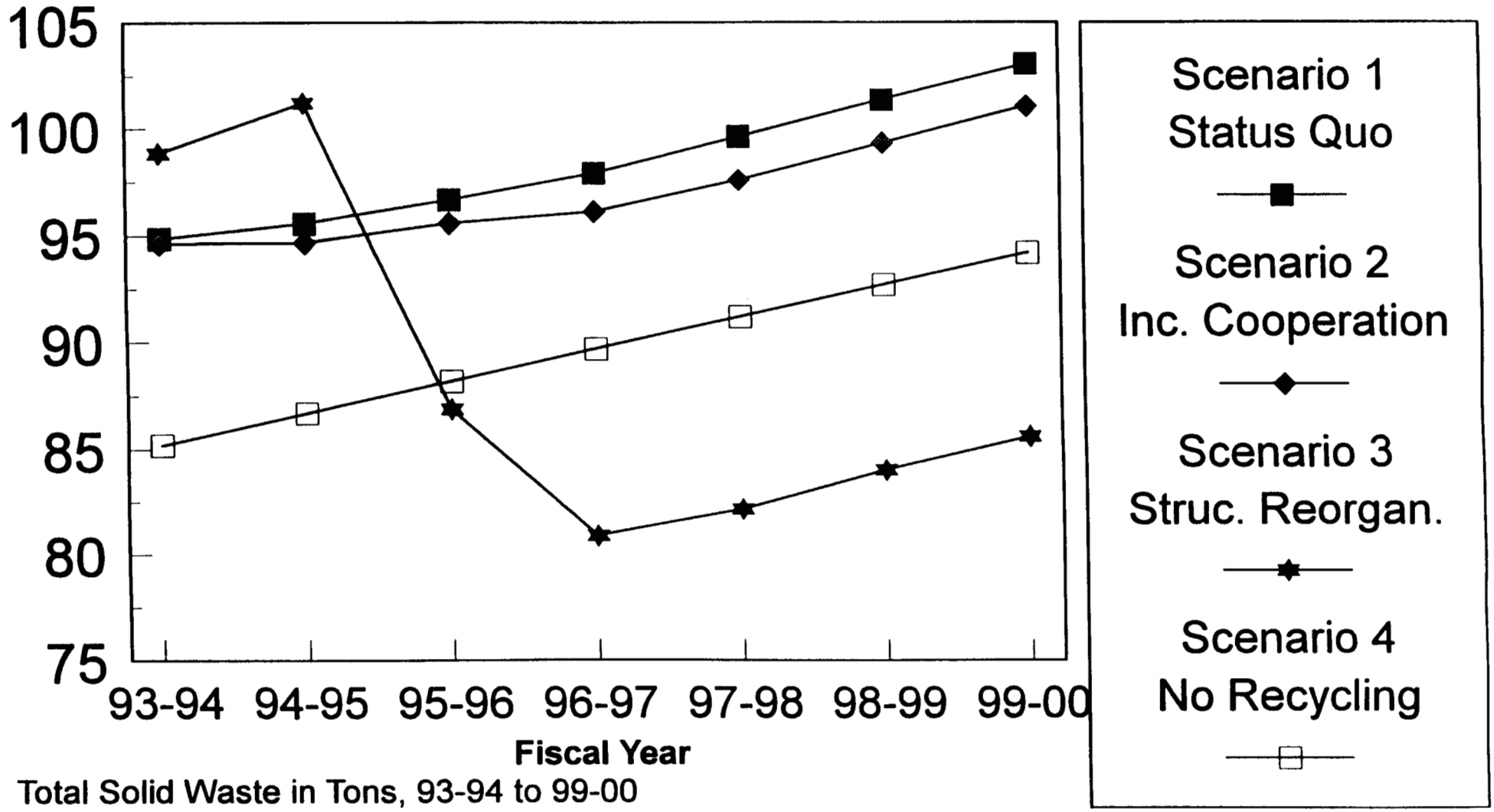
Total Solid Waste in tons, 93-94 to 99-00:
11489, 12064,12667,13300,13965,14663,15397

Chart 2

A Comparison of Scenarios 1-4

(Low-Level Pricing, Slowly Increasing Tipping Fees)

$/ton Cost of All Solid Waste Management



Total Solid Waste in Tons, 93-94 to 99-00

11489, 12064, 12667, 13300, 13965, 14663, 15397

I. INTRODUCTION

Duke University has made a commitment to a recycling program beginning in late 1989, and has continued to fund progressive solid waste management systems to provide for the sanitary and efficient removal of solid waste from the Duke campus. Both the recycling and solid waste management programs, are responsible for the removal of waste materials from the University. Greater than 85% of the waste is being hauled to the Durham landfill and less than 15% of the waste is being recovered and returned to productive use by the recycling groups.

In this study we have attempted to consider all the elements of solid waste management at Duke and generate some comparative data which will be helpful in providing information to aid future management decisions in this area. Our main emphasis has been on identifying several alternatives and focusing on the economic elements of each. Duke should select the best solid waste management practice which is most compatible with it's long term economic best interest.

There are many variables which must be considered in long term management planning, therefore, some of our conclusions and recommendations will of necessity be general in nature. Since we cannot with total accuracy predict the future, we must base our evaluations and conclusions on the information we have available and reasonable projections. Projections associated with solid waste are even more tenuous than most because of constantly changing technology, regulations, and public interest and demands. Newspaper articles in the Appendix demonstrate this.

Throughout this document we have chosen to use the word scenario to describe the options and/or alternatives available to Duke for the long term management of the campus solid waste. We felt the word scenario implied a broad view, although the terms alternative and/or option could have been used interchangeably with it.

PURPOSE

The purpose of this study has been to collect data from solid waste management sources and agencies at the University, assess the information, present the findings and develop conclusions and recommendations which could be used by Duke University Management to affect solid waste management decisions.

By establishing valid information and documenting, projecting, and organizing cost data this study provides a tool that the University can use to establish a long term economically viable, and environmentally responsible waste management program.

SCOPE

This study examines data relative to costs, waste generation/characterization, current efforts, limitations and materials generated by the Duke University Medical Center Recycle and Read program, Duke University Recycles, and the Duke Sanitation Department.

The study also surveyed by personal interview managers in various positions in the University community to collect information from their perspective, to assess their understanding of the issues, and identify their problems and needs.

In this study, we develop economic and waste generation data relative to four (4) potential solid waste/recycling management scenarios (it must be noted that there may be others which we have not studied). These scenarios cover a period of seven fiscal years from 1993 to 2000.

The Studied Scenarios are:

- #1 Status Quo - no changes of current programs or operations.

- #2 Increased Cooperation - operational management structure remains unchanged but there will be increased cooperation between different programs aimed at potential waste stream reduction of up to 40%. This scenario would require some operational and political changes by the campus, and some up front increases in expenses for education, recycling collection devices, additional square footage for recycling, some increased processing and collection capability, and an increase in personnel requirements.

- #3 Structural Reorganization - consolidation/integration of recycling and solid waste management programs and significant alterations of collection and processing systems aimed at achieving up to 80% reduction of the waste stream. This scenario would require significant management structure changes, redesign of collection and transportation systems, the implementation of a compost program and a major educational effort to create the atmosphere in which such change would occur without too many hitches. Implementation of this scenario would require a cooperative effort on the part of all the players involved.

- #4 "Go back to square one" - elimination of recycling as part of the solid waste management program.

METHODOLOGY

Departmental budgets, current, past and planned, and waste hauling, recycling records and material sales records were studied and incorporated into the presentation of comparative data for this study. Weighted averages were used in Scenario's One and Two to demonstrate the total cost per ton of solid waste management including all sanitation and recycling.

Interviews were accomplished with the following members of Duke's staff from the following areas:

Mr. Regis Koslofsky, Director, Facilities Administration
Mr. F. Wesley Newman, Director, Dining and Special Events
Mr. S.T. Van Campen, General Manager, Surplus Sales
Mr. John Pearce, University Architect
Mr. Paul Brummett and Mr. Joe Alston, Director and Associate Director
Material Support Department
Ms. Evelyn Hicks, Senior Buyer, Material Department
Mr. David Jackson, Grounds
Mr. David Bryant, Sanitation
Mr. John Marsh, DUMC
Mr. Chuck Reveal, DUMC
Mr. Bob Linehart, DUMC
Mr. Michael Smith, DUMC
Mr. Judson Edeburn, School of Environment
Mr. Jimmie Johnson, Director, Housekeeping Services

Some site visits were made at Duke University Medical Center and other facilities on the campus to help create a better understanding of the systems currently being used for waste management.

The main progenitors of this report, Stephanie Finn and Randy Bowen have carried on a regular dialogue and review process. In meetings we have developed the critical elements of this report and "culled" the information we considered extraneous or unrealistic and not worthy of further study.

In each net cost/benefit scenario we have presented the cost per ton for conventional solid waste management under two tipping fee structures. One structure assumes moderately increasing tipping fees from a current level of $39.50/ton to $69.00/ton in the year 2000. The other assumes slowly increasing tipping fees from the current level of $39.50/ton to $48.50 in the year 2000. Although we believe that tipping

fees will rise according to the moderately increasing fee structure and possibly exceed it, we have used the slowly increasing tipping fee structure as what we consider to be the most conservative estimate. We do not expect tipping fees to remain the same or decrease. For solid waste management we have projected a 5% growth rate for the waste management cost centers and no other variables.

We have used the same tipping fee structure in developing the net cost/benefit comparisons for recycling. We have also used an estimated 5% growth rate for all cost centers for recycling management; however, the amount of material recovered over time by recycling is not projected using a 5% (steady) rate of growth.

In Scenario One the amount recovered stabilizes during FY 1996-97, when we feel the maximum level of recovery would be achieved. In Scenarios Two and Three the growth in tonnages recovered is rapid after implementation and then levels off in accordance with our best, conservative estimate. The other variable in the cost/benefit comparative data for recycling occurs under the three pricing structures for recovered materials.

In Scenario's One and Two we have provided a weighted cost for solid waste management in order to provide for meaningful comparisons to Scenario Three under which all solid waste/recycling management entities are combined (see Figure 16, Appendix).

These comparative figures provide the basis of demonstration for the potential costs/ton in each scenario.

ISSUES NOT ADDRESSED

1. Specific spatial and system design requirements for the campus recycling programs are not addressed.

2. There is no incineration/incineration for energy recovery locally; there is a coal plant on campus. We did not evaluate the long term potential energy value of "trash".

3. Detailed implementation plans or budgets for each scenario were not developed.

4. Detailed management implementation plans are not included and can not be generated until overall direction is decided upon.

5. There are potential significant cost savings by reusing in house composted products for landscaping projects. Attempts to quantify those savings were not included in the scope of this study.

6. The feasibility of Duke using contract services to implement parts of its waste management program was not evaluated.

ACKNOWLEDGEMENTS

During the late 1980's the student population provided the impetus for the beginning of the Duke University Recycling programs. Interested students met with the Director of Material Support and a partnership was formed to create a recycling program. A study done by a group of students in consultation with the Director of Material Support began this process. Their initial inputs and drive to develop a program have led to the point that Duke is today. This report/study is a natural step in the process they started. Currently in continuation of student participation, the Duke Recycles program utilizes 15 student workers in it's efforts, as well as 3 full time staff and is assigned to the Material Support Department. Their efforts have been and are important.

We would also like to thank the University personnel previously listed in Section I, and their departments for providing us their time and the data needed to generate the presentation of this information. To a person their inputs indicated support for the recycling efforts, however, it must be noted that they had reservations on how a program to increase recycling would be received politically, and how any significant program changes could be implemented.

During the process of developing this project Stephanie Finn has worked diligently and beyond the call of duty in accumulating and presenting the information contained in Scenarios One through Four. We have carried on a regular dialogue and review process to develop the critical elements of this report. Her effort has been significant.

II. BACKGROUND

In 1989 the State of North Carolina enacted the Solid Waste Management Act of 1989 (SB 111) which required counties and/or local governments to reduce the amount of waste being sent to landfills. It established a preferred hierarchy for waste management: waste reduction at source, recycling and reuse, composting, incineration with energy production, incineration with volume reduction, and disposal in landfills. It also banned white goods, yard waste, lead acid batteries, tires, and oil from the landfill and required each county to achieve a recycling rate of 25% by 1993. Under HB 1109 (Amendments to the Solid Waste Management Laws), this requirement was later changed to a 25% waste reduction rate by June 30, 1993 and a 40% rate by June 30, 2001.

While these reduction goals and landfill requirements do not apply to Duke University directly, they do apply to the City and County of Durham. As a large waste generator in Durham, it is important that Duke reduce its waste and help the city achieve the goals. Duke University produces approximately 11,000 tons per year, or 5% of the "trash" sent to the city landfill.

In addition to state guidelines, Durham has a very real need to reduce its waste; the landfill currently operated by the City of Durham will close in 1995. In the future, waste will be transported by rail to a landfill in another county.[1]

All of the factors noted above have had an obvious effect upon the cost of waste management at Duke. The tipping fee (fee to dispose one ton of trash at the landfill) increased from $7.00/ton in 1988 to $39.50/ton in 1993. According to one city official, tipping fees may reach $69.00/ton by 1998.[2] However, it is difficult to predict just what will happen to tipping fees. A legal debate currently exists as to whether cities can lay claim to the trash generated within their boundaries (flow control). If a city does not control the waste stream, it must consider market forces while setting its rates. If fees rise too steeply, large waste generators will have an incentive to look for other landfills or other methodology in which to dispose of their trash.

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[1] After the current landfill is closed in 1995, waste will be taken first to a transfer station within the city's boundaries. There it will be weighed and recontainerized for shipment out-of-county. (City of Durham, Solid Waste Management Plan, March 1993).

[2] These figures were obtained from a conversation with Tom Bastable on 7/2/93. In September of 1992, the Budget Officer for the City of Durham, Harmon Crutchfield indicated that the tipping fees would be as high as $98/ton.

Duke University has joined a task force of companies which also includes The Prudential, Nations Bank, McDonalds, Time, Inc., Environmental Defense Fund, and Johnson and Johnson. The task force is seeking to build environmental criteria into the purchase of paper products, with efforts directed toward changing the way paper is produced, purchased, and used in the United States. Paper is the largest component of Duke University's waste stream. It is projected that buying more environmentally preferable paper will increase demand for and sale of paper collected for recycling, developing a stronger market for recycled paper and helping close the recycling loop. By joining this task force Duke University has thrust itself into a national leadership role which will inevitably influence the business of recycling as one method of managing solid waste. [3]

Recent studies in the State of Washington have shown that recycling as a means of solid waste management is less costly than conventional means of solid waste management in four Washington cities. An article in the November 1993 World Waste Magazine condenses the information developed in this study titled "The Economics of Recycling and Recycled Materials" accomplished by the Clean Washington Center in June, 1993. [4]

There have also been recent articles in local newspapers concerning Durham's Waste Management issues which have relevance to Duke University's Waste Management programs. These articles are included in the Appendix.

HISTORY OF RECYCLING AT DUKE UNIVERSITY

In 1988, environmentally concerned Duke students, staff and faculty formed the University Resource Recovery Cooperative (URRC) to convince the University to fund a recycling and waste reduction program. URRC (later, Duke University Recycling Cooperation, DURC) circulated a preliminary proposal among University administrators. In 1989, the Material Support Department hired two students to write a proposal for a recycling program. The proposal was accepted and in January 1990 a full-time recycling coordinator was hired to manage Duke Recycles. Recycling collections began in February 1990 in four campus buildings.

Since that time the recycling program has grown extensively. In FY 89-90 only 83 tons of all materials were collected. In FY's 90-93, 390, 500, and 624 tons were

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[3] 8/18/93 press release, copy in Appendix.

[4] Copy in Appendix

collected, respectively. Over 800 tons are predicted to be collected in FY 93-94 and thus reduce the cost per ton of recycling. Recycling services are now provided to virtually every campus building, many off-campus buildings and some medical center buildings by Duke Recycles. Complete tonnage figures for each Fiscal Year are given in Charts 1 and 2 in the Appendix.

Duke Recycles has operated an extensive collection system with a small staff. From January 1990 to July 1992 the staff consisted of one full time employee and 6-16 part-time student employees. In July 1992, a second full time employee was added. In September 1993, a third full time employee was added to the staff. As demand for recycling services has grown, additional full-time employees have been added to provide consistency during student transition times and improve efficiency. However, students continue to be an essential part of Duke Recycles.

Initially, Duke Recycles collected only aluminum cans, white paper, newspaper, cardboard, and blend paper. Due to the demand for expanded service and the development of local markets, the program now accepts magazines, tin cans, three colors of glass, and two grades of blend paper. Mixed paper, phone books and polystyrene peanuts are accepted as markets permit. Although Duke Recycles is able to market a variety of materials, the potential for greater recovery of each material type is quite high (see Figures 1 and 2 in the Appendix). Furthermore, Duke Recycles does not collect plastics, organics and construction and demolition waste. The Duke University Surplus Store, which for many years has operated an extensive salvage and scrap metal recycling program, diverts large items from the waste stream. These items include furniture, machinery, and electrical equipment.

In addition to the recycling efforts of Duke Recycles, the Duke University Medical Center (DUMC) has operated its own parallel recycling program, DUMC Recycle and Read. Although Duke Recycles and DUMC Recycle and Read collaborate on some projects, for the most part, they are independent entities. Tonnage figures for the DUMC program are given in Charts 1 and 2 in the Appendix. DUMC Recycle and Read focuses on blend paper, cardboard and aluminum can recycling. However, markets are available for glass, plastic and other grades of paper. The DUMC Recycle and Read program is recovering a small percentage of its waste stream in comparison to the recycling program for the remainder of the University. This is demonstrated by Chart 1 and Figures 1 and 2 in the Appendix.

Chart 3 in the Appendix summarizes waste composition at the University. Waste composition figures are given for both the non-medical and medical center buildings. University waste composition percentages are based on published literature, reports from other institutions and observation. Medical Center figures are taken from a consulting study done by Prete-Wilmot Associates. Waste composition data from the

two areas are shown separately, because the two areas are intrinsically different. Overall, the Medical Center/Hospital accounts for approximately 55% of the waste stream and the University accounts for 45% (Chart 4, Appendix).

Figures 1 and 2 in the Appendix detail the projected waste stream by material type. An assumption was made that all waste will grow uniformly at 5% per year. This assumption was made throughout this report and is based on the continued growth in the number of buildings at Duke. Currently, there are 8,866,534 square feet at the University. In FY 94-95, 629,500 square feet will be added to the University (+7%).[5] Thus, a 5% growth for the coming year is reasonable (and perhaps conservative). However, the growth rate for trash production may decrease. Many companies are making tremendous efforts to reduce their packaging waste. Duke's own purchasing department continues to persuade its vendors to reduce their packaging waste. This will certainly affect the University's waste stream in the future.

The history of solid waste at Duke is shown in the Appendix in Figure 3 and in Chart 5. Although progress reducing waste has been made since 1990, Duke University still produces approximately 11,000 tons of waste each year. Coordination of the efforts of Duke Recycles with Duke Sanitation and Medical Center Recycling will certainly increase the efficacy of the overall waste reduction program.

HISTORY OF SANITATION

Duke University has a Sanitation Department which handles trash from the entire University. Since 1984, it has had the same level of personnel and equipment. Currently, the department employs six full-time employees and one supervisor. The department operates two front-loading garbage vehicles, four roll-off trucks, one rear-loader and one side-loader.[6] There is additional capacity for growth in the Sanitation Department, and their well established equipment replacement budget could be utilized to facilitate further recycling.

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[5] Information obtained from Dan Parlor, Plant Accounting, November 1993.

[6] David Bryant, Sanitation Department, November 1993.

FINANCIAL HISTORY OF SOLID WASTE MANAGEMENT

Since FY 89-90, Duke Recycles has had its own operating budget. Expenses, revenues, avoided costs[7] and cost per ton for FY 89-90 through FY 93-94 are shown in Figure 4 in the Appendix. The same information is duplicated for DUMC Recycle and Read. Please note that the Duke Recycles figures are taken straight from the financial statements, while the DUMC numbers are estimated figures taken from the consulting study done by Prete-Wilmot Associates in January 1993. The figures for DUMC Recycle and Read include estimated labor costs but do not include vehicle costs. Also note that in FY 91-92, some of Duke Recycles expenses were borne by the Surplus Store and the Materials Support central office and do not appear on the Duke Recycles financial statement.

Figure 4 in the Appendix combines the budgets of both programs. It indicates the total cost of all recycling activity at the University, as well as a cost per ton recycled. This cost per ton is calculated by dividing the net cost by the number of tons recycled.

For Duke Recycles, the initial cost per recycled ton in FY 89-90 was $671.65/ton. This high cost per ton is directly related to the fact that 89-90 was a start-up year. Very little was collected that year, but costs were incurred prior to actual collections for bins, personnel, staff studies, etc. In the second year of the Duke Recycles program, the cost per ton dropped sharply to $102.46/ton. Since that year the cost per recycled ton has settled around the $100/ton mark (excluding FY 91-92 which needs to be adjusted upwards). It is expected that during this current fiscal year the cost per ton will drop below $100/ton.

For DUMC Recycle and Read the cost per ton has declined from $285.90 per ton to $219.24/ton. Please note that in order to avoid double counting, revenue from the sale of aluminum cans is excluded from the DUMC figures. This is due to the fact that DUMC "sells" its aluminum to Duke Recycles. Duke Recycles has access to better markets because of its higher volume.

It is perhaps more appropriate to look at the combined cost per ton recycled. Since FY 89-90 this figure has declined from $176.12/ton to an estimated $124.10/ton for 93-94. Again, whether this cost would be decreased even further is the subject of

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[7]Avoided costs refer to the costs eliminated when trash is diverted from the landfill. Here, it specifically refers to the reduction in tipping fees paid when materials are recycled. The tipping fee is the fee paid at the landfill to "tip" a ton of trash and is easily calculated. Some people also calculate avoided costs based on reductions in labor, transportation, equipment and other costs. This is more difficult to do, as it is less clear when one can legitimately assume reduction in these costs.

the rest of this document. It is our belief that if all recycling operations can be made more efficient, the overall cost of recycling can decline even further.

As a basis of comparison, please note that efficient curbside recycling programs cost between $110-$150/ton (excluding avoided costs). The net cost of recycling in Seattle is $91/ton.[8]

The overall costs for all solid waste management (Recycling and Sanitation) at Duke for FY 91-92 through FY 93-94 are shown in Figure 5 in the Appendix . In FY 93-94 Duke Sanitation will spend an estimated $90.46 for each ton of trash it hauls to the landfill (Figure 2, page 17).

In the next sections, we detail several different scenarios and demonstrate the impact of each on the cost of solid waste management at Duke University.

[8] Biocycle Magazine, September 1993.

III. FUTURE OPTIONS FOR SOLID WASTE MANAGEMENT

In this section, we develop different options for waste management at Duke University in the future. With regard to some aspects of each option, we have been able to provide a fair amount of detailed numerical information. With regard to other aspects, where information is more speculative or would take further investigation to have any degree of accuracy, we have confined ourselves to qualitative descriptions. Please note that the scenarios as we have labeled them, are meant to be broad, general descriptions. In no case are they assumed to be totally reflective of current or future activities or operations. The scenarios are merely tools to help guide future management decisions.

For the purpose of this study, certain projections/assumptions are required to evaluate waste management scenarios for the future. The following assumptions are utilized in this report:

- Growth in Duke's solid waste stream - 5%/year
- Increased tipping fees, moderate vs. slow - tipping fees are officially determined by Durham Government. We have used our best estimates based on past history and discussions with officials.
- Increased personnel costs - 5%/year
- Value ranges for recycled materials - experience, public market information, etc.
- Duke University would have the desire or need to establish long term cost reduction in creating a best management scenario for solid waste.
- Scenario's Two and Three would at a minimum require some major behavior modification on the art of Duke faculty, staff, and students, and would also require some level of investment in new collection and processing systems.

There are social and political issues which must be addressed. We have not attempted to quantify the cost of addressing these issues except by recommending an educational program be established as the first step. These issues include:

- Integration of Duke University Medical Center Recycle and Read and Duke Recycles
- Consolidation of Sanitation and Recycling

- The cooperation and participation of employees, students, faculty, especially those involved in the removal, and collection of Solid Waste/Recyclables.

- How to reward successful efforts, especially on the part of Duke staff.

- How to get academic areas to participate by providing technical or project assistance, possibly in the form of class study or individual projects. Stephanie Finn can provide subjects for various departments to use as potential project work. The integrated management and recovery of solid waste involves the disciplines of business, engineering, and the biological sciences; and is a challenge to the State University system in Senate Bill 111.

The four scenarios considered in this study are briefly described below:

1) Scenario One--Status Quo. This scenario assumes that the recycling and sanitation departments will continue to operate as they do presently. There will be no change in management structure. In this scenario, overall waste reduction will occur at a rate somewhere between 12% to 15%.

2) Scenario Two--Increased Cooperation between Departments. This scenario assumes that the management structure of the recycling and sanitation areas will remain the same, but there will be increased efforts to coordinate cooperation, greater participation of housekeeping and some improvements to the recycling facilities. This scenario should result in waste reduction ranging from approximately 20% to 40%.

3) Scenario Three-- Structural Reorganization. This scenario assumes that there will be a restructuring of Sanitation and Recycling into a Solid Waste Management Department. Merger of all areas handling solid waste will allow for increased efficiencies, greater cooperation and planning. Under this scenario anywhere from between 40% to 80% waste reduction can be achieved. At the 80% end of this scenario, it is assumed that a composting program has been instituted.

4) Scenario Four-- No recycling. This scenario demonstrates the consequences of reverting to a 0% waste reduction strategy.

SCENARIO ONE: STATUS QUO.

Currently, Duke Recycles and DUMC Recycle and Read operate two almost completely autonomous recycling programs. Both programs collect recyclables from campus buildings, take them to a central processing area, and sell the materials out of this central location. Duke Sanitation collects the trash generated by the campus and assists with the hauling of some recyclables (cardboard for the hospital, white goods, and newspaper for Duke Recycles.). In this scenario, we make projections which assume the continuance of this system. The details of this scenario are shown in Figures 1 through 4, pages 16 through 19 and in background data developed in the Figures and Charts in the Appendix.

The Duke Recycles program shows some growth under this option, but it eventually levels out. DUMC Recycle and Read is shown as reaching a plateau rather quickly. We did our best to predict tonnage levels for each material based on present trends. We know DUKE Recycles can handle 80 tons per month, thus, it seemed reasonable to base an upward tonnage limit between 90-100 tons per month.

The overall cost per recycled ton (for Duke Recycles) is calculated using two different tipping fee scales and three different revenue scales. The tipping fees used are as follows:

a) slowly increasing tipping fees--$39.50, $41.00, $42.50, $44.00, $$45.50, $47.00, and $48.50.
b) moderately increasing tipping fees--$39.50, $53.00, $60.00, $66.00, $68.00, and $69.00. (Also listed in chart 6, appendix)

These two tipping fee scales reflect our and Durham's uncertainty about the future direction of tipping fees. Tipping fees could exceed $69.00/ton in the future.

Different revenue rates for recyclables were used to reflect uncertainty about market conditions. Overall, the pricing levels chosen tend to be on the conservative side. On the low-level pricing basis we have used pricing comparable to what Duke is currently receiving for its recycled materials. The mid-level pricing provides for moderate increases in value, and the high-level pricing reflects the current valuation of materials that is available to generators of larger quantities of recycled materials.

In all likelihood, the different materials would never be all low, all medium or all high value, but a mixture of low, medium, and high value. Furthermore, a simple modification made to the existing programs, i.e., the ability to store greater amounts of materials before shipping them, would allow for truckload quantity prices (high level).

In this scenario, it is demonstrated that the costs for conventional solid waste management continue to rise under both landfill tipping fee projections. Using moderately increasing tipping fees, $39.50/ton to $69.00/ton, until the year 2000 the cost per ton of solid waste management rises to almost $120/ton (see Figure 2, page 17). Using the slowly increasing tipping fee model, 39.50/ton to 48.50/ton, the cost per ton rises to almost $99.00/ton (see Figure 2, page 17). Any methodology which would keep the cost per ton under these levels is worthy of further evaluation. The recycling model of Scenario One shows that the cost per ton for solid waste management by recycling is reduced, and actually falls below the cost per ton of conventional solid waste management, until the year 1996-97 when the maximum level of recovery is reached (see data in Figures 3 and 4, pages 18 and 19). This trend is demonstrated at all the pricing levels of recyclables, and for both tipping fee projections.

FIGURE 1

SCENARIO ONE: STATUS QUO

SANITATION COSTS

Waste generation (in tons).

Area	93–94	94–95	95–96	96–97	97–98	98–99	99–00
University	5143.53	5400.71	5670.74	5954.28	6251.99	6564.59	6892.82
Medical Center	6346.07	6663.38	6996.55	7346.37	7713.69	8099.38	8504.35
Recycled Tons	−1189.44	−1318.44	−1400.44	−1467.44	−1467.44	−1467.44	−1467.44
Total landfilled	10300.16	10745.65	11266.85	11833.21	12498.24	13196.53	13929.73

Projected Tipping Fees Paid Per Year: Moderate Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Total Fees	406856.32	569519.45	676011.00	780991.86	849880.32	910560.57	961151.37

Projected Tiping Fees Paid Per Year: Slow Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Total Fees	406856.32	440571.65	478841.13	520661.24	568669.92	620236.91	675591.91

FIGURE 2

SCENARIO ONE: STATUS QUO

NET COST/BENEFIT SANITATION COSTS:	MODERATELY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees*	406856.32	569519.45	676011.00	780991.86	849880.32	910560.57	961151.37
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	931705.32	1120610.90	1254657.02	1388570.18	1487837.56	1580415.67	1664499.23
Cost/ton	90.46	104.29	111.36	117.35	119.04	119.76	119.49

NET COST/BENEFIT SANITATION COSTS:	SLOWLY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees*	406856.32	440571.65	478841.13	520661.24	568669.92	620236.91	675591.91
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	931705.32	991663.10	1057487.15	1128239.56	1206627.16	1290092.01	1378939.76
Cost/ton	90.46	92.29	93.86	95.35	96.54	97.76	98.99

* Tipping Fees for FY 93–94 are based on the actual tipping fees of $39.50/ton and not the original Duke budget projections of $49/ton.

FIGURE 3

SCENARIO ONE: STATUS QUO

COMBINED COST OF SANITATION AND RECYCLING

WEIGHTED AVERAGE COST/TON
LOW-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	104.29	111.36	117.35	119.04	119.76	119.49
Recycling Cost/ton	133.02	110.36	101.67	96.62	103.36	111.54	121.18
Weighted avg. Cost/ton	94.86	104.95	110.29	115.06	117.40	118.94	119.65

WEIGHTED AVERAGE COST/TON
MID-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	104.29	111.36	117.35	119.04	119.76	119.49
Recycling Cost/ton	122.81	99.80	91.36	86.32	93.06	101.24	110.88
Weighted avg. Cost/ton	93.80	103.79	109.15	113.92	116.31	117.91	118.67

WEIGHTED AVERAGE COST/TON
HIGH-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	104.29	111.36	117.35	119.04	119.76	119.49
Recycling Cost/ton	102.08	86.38	77.74	73.08	79.82	88.00	97.64
Weighted avg. Cost/ton	91.66	102.33	107.64	112.46	114.92	116.58	117.41

Note: The weighted average cost/ton is calculated using the following formula:

$$\text{Weighted Average} = \frac{(\text{recycling cost/ton})(\text{no. of tons recycled}) + (\text{sanitation cost/ton})(\text{no. of tons landfilled})}{(\text{no. of tons recycled}) + (\text{no. of tons landfilled})}$$

FIGURE 4

SCENARIO ONE: STATUS QUO

COMBINED COST OF SANITATION AND RECYCLING

WEIGHTED AVERAGE COST/TON
LOW-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	92.29	93.86	95.35	96.54	97.76	98.99
Recycling Cost/ton	133.02	122.36	119.17	118.62	125.86	133.54	141.68
Weighted avg. Cost/ton	94.86	95.57	96.66	97.91	99.62	101.34	103.06

WEIGHTED AVERAGE COST/TON
MID-LEVEL PRICING, SLOWLY INCREASING T TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	92.29	93.86	95.35	96.54	97.76	98.99
Recycling Cost/ton	122.81	118.80	108.86	108.32	115.56	123.24	131.38
Weighted avg. Cost/ton	93.80	95.18	95.52	96.78	98.54	100.31	102.08

WEIGHTED AVERAGE COST/TON
HIGH-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.46	92.29	93.86	95.35	96.54	97.76	98.99
Recycling Cost/ton	109.62	98.38	95.24	95.08	102.32	110.00	118.14
Weighted avg. Cost/ton	92.44	92.95	94.01	95.32	97.15	98.98	100.82

Note: The weighted average cost/ton is calculated using the following formula:

$$\text{Weighted Average} = \frac{(\text{recycling cost/ton})(\text{no. of tons recycled}) + (\text{sanitation cost/ton})(\text{no. of tons landfilled})}{(\text{no. of tons recycled}) + (\text{no. of tons landfilled})}$$

SCENARIO TWO: INCREASED COOPERATION

Figures 5 through 12 on pages 22 through 29 and Figures 12 and 13 in the Appendix develop the costs of operations in this scenario.

If Duke Recycles, DUMC Recycle and Read, Duke Sanitation and Housekeeping were to coordinate their efforts to a much greater extent, a higher waste diversion rate could be achieved. Although, it is difficult to say exactly how much could be diverted, we estimate that it would be on the order of up to 40%.

This scenario assumes that while greater cooperation will be developed among departments, each department will maintain its autonomy.

Key to this scenario is the increased use of resident staff in buildings (i.e. housekeepers). Currently, Duke Recycles empties all of the recycling bins located in academic and administrative buildings. In the dormitories, Housekeeping empties internal recycling bins; Duke Recycles empties external drop-off bins. DUMC R&R enters many Medical Center buildings; however, in some areas, Environmental Services empties the recycling bins into central bins located on a loading dock. The labor intensiveness of this collection method, coupled with the relatively small size of the recycling staffs, make it difficult to maximize collections. If Housekeeping's involvement were increased, the number of collection points within each building could be increased. The greater convenience of recycling bins would most certainly increase the amount of material collected. It must be noted that this change in methodology would not increase the amounts handled, just the way it is done. The Bryan Center provides us with a good example of how a change in handling can lead to a dramatic reduction in trash generation. In the Fall of 1993, Duke Recycles began an intensive campaign to enlist the support of Dining Services and Duke Stores in cardboard recycling at the Bryan Center. As a result of this effort, the number of compactor "pulls" has been reduced by 50%. This significant reduction in trash simply required the placing of cardboard in a separate bin. There was no added expense for the building (in fact, trash charges may decrease by $14,000 in FY 94-95).

If such a system were implemented there would be substantial start-up costs. The size and type of recycling bins would need to be changed (many current recycling bins hold between 50-200 lbs when full). In addition to internal bins, external bins (probably 90 gallon roll-out carts) would need to be purchased. There would need to be changes to the recycling processing area to accommodate greater volumes. A new recycling vehicle would most likely need to be purchased. Some of these expenses could be accommodated within the current budget structure, and some could not. These estimated start-up costs are given in Figure 6, page 23.

This scenario also assumes that DUMC Recycle and Read would deliver its materials to the Duke Recycles lot for processing and sale. Greater combined volumes would enable the maximization of revenues. A bookkeeping system would need to be developed to keep track of materials brought in by DUMC Recycle and Read such that it could receive revenues for its materials.

The projected waste recovery for Duke Recycles and DUMC Recycle and Read are shown in Figures 12 and 13 in the Appendix. Figure 13 gives the combined tonnage of the two programs. Again, costs per ton are calculated using slowly and moderately increasing tipping fees and low, medium and high revenues.

The expense spreadsheet (Figure 6, page 23) combines the budgets of Duke Recycles and DUMC Recycle and Read (even though each still maintains its own budget in this scenario). The expenditures for personnel are increased in this option. Since in this scenario, tonnage doubles, we have doubled the personnel budget for operations. Currently, a total of 4 full time employees are employed by the two programs combined (including management staff). In this scenario, 3 more full time employees, (level 5) would be added, and management staff remains the same.

In this scenario (see Figures 7 and 8 on Pages 24 and 25), using high level pricing and moderately increasing tipping fees the cost/ton or net cost/benefit of recycling decreases to approximately $28/ton in the year 96-97 when the total quantities of materials recovered begin to stabilize. Increased costs/ton are then attributable, up to about $40/ton in the year 2000, to the annual increases in expenses relative to the limited growth in revenues and avoided landfill tipping fees. In the case least favorable to recycling (low tipping fees, low revenues), the cost per ton drops as low as $77.17 per ton, before leveling off at $88.88 per ton. In this scenario the cost of conventional solid waste management, using moderately increasing tipping fees, rises from about $90.00/ton to about $124.00.

The weighted cost for all solid waste management is approximately $104/ton in 96-97 and rises to approximately $109/ton in the FY 1999-2000. Figures 11 and 12 on pages 28 and 29 demonstrate the combined (weighted average) cost of solid waste management in this scenario.

FIGURE 5

SCENARIO TWO: INCREASED COOPERATION

REVENUES BASED ON LOW-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	10.00	2432.70	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00
News	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White	20.00	3260.00	7520.00	8020.00	8520.00	9020.00	9020.00	9020.00
CPO	120.00	2400.00	2400.00	2400.00	2400.00	2400.00	2400.00	2400.00
Mixed Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glass	15.00	2340.00	3750.00	4500.00	6000.00	6000.00	6000.00	6000.00
Aluminum	500.00	7000.00	8000.00	9000.00	10000.00	11000.00	12000.00	13000.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		17432.70	26470.00	28720.00	31720.00	33220.00	34220.00	35220.00

REVENUES BASED ON MID-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	15.00	3649.05	7200.00	7200.00	7200.00	7200.00	7200.00	7200.00
News	5.00	730.00	1960.00	1960.00	1960.00	1960.00	1960.00	1960.00
White	40.00	6520.00	15040.00	16040.00	17040.00	18040.00	18040.00	18040.00
CPO	150.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00
Mixed Paper	10.00	3551.70	6500.00	6500.00	6500.00	6500.00	6500.00	6500.00
Glass	30.00	4680.00	7500.00	9000.00	12000.00	12000.00	12000.00	12000.00
Aluminum	600	8400.00	9600.00	10800.00	12000.00	13200.00	14400	15600
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	40.00	40.00	520.00	1040.00	1560.00	1600.00	1640.00	1680.00
Tin	10.00	10.00	30.00	60.00	120.00	120.00	120.00	120.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		30580.75	51350.00	55600.00	61380.00	63620.00	64860.00	66100.00

REVENUES BASED ON HIGH-LEVEL PRICES FORE EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	35.00	8514.45	16800.00	16800.00	16800.00	16800.00	16800.00	16800.00
News	15.00	2190.00	5880.00	5880.00	5880.00	5880.00	5880.00	5880.00
White	80.00	13040.00	30080.00	32080.00	34080.00	36080.00	36080.00	36080.00
CPO	240.00	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00
Mixed Paper	10.00	3551.70	6500.00	6500.00	6500.00	6500.00	6500.00	6500.00
Glass	40.00	6240.00	10000.00	12000.00	16000.00	16000.00	16000.00	16000.00
Aluminum	700.00	9800.00	11200.00	12600.00	14000.00	15400.00	16800.00	18200
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	60.00	60.00	780.00	1560.00	2340.00	2400.00	2460.00	2520.00
Tin	70.00	70.00	210.00	420.00	840.00	840.00	840.00	840.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		48266.15	86250.00	92640.00	101240.00	104700.00	106160.00	107620.00

FIGURE 6

SCENARIO TWO: INCREASED COOPERATION

EXPENSES

Item	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel	175504.00	232279.20	243893.16	256087.82	268892.21	282336.82	296453.66
Fringe	14759.00	25096.95	26351.80	27669.39	29052.86	30505.50	32030.77
Auto M&R	4200.00	4410.00	4630.50	4862.03	5105.13	5360.38	5628.40
Bins	6180.00	6489.00	6813.45	7154.12	7511.83	7887.42	8281.79
Publicity	2590.00	25000.00	25000.00	25000.00	25000.00	25000.00	25000.00
Depreciation	9800.00	10290.00	10804.50	11344.73	11911.96	12507.56	13132.94
Additional Depreciation	2142.86	2142.86	2142.86	2142.86	2142.86	2142.86	2142.86
Other	8607.00	9037.35	9489.22	9963.68	10461.86	10984.96	11534.20
Total	223782.86	314745.36	329125.48	344224.61	360078.70	376725.49	394204.63

NOTES:

PERSONNEL:
Personnel budget for FY 94–95 and beyond contains the following items:
– – 3FTEs and 12 part–time students (same as current Duke Recycles budget).
– –1 FTE for DUMC Rcycle and Read (same as current budget).
– –3 additional FTEs (level 5 employees)

ADDITIONAL START–UP EXPENSE

These additional start–up expenses (except depreciation) are not included in the budget above.

Item	Amount
Bins	30000.00
Roll–out Carts	60000.00
Truck	20000.00
Facility Modifications	60000.00
Total	170000.00

Bins are estimated at 100 buildings x 10 bins/bldg. x $3/bin.
Roll–outs are estimated at 100 buildings x 10 carts/bldg. x $6/bin.

Additional truck is depreciated over 7 years:

cost of truck:	20000
life of truck	7
salvage value	5000
annual depreciation	2142.86

FIGURE 7
SCENARIO TWO: INCREASED COOPERATION

NET COST/BENEFIT
)W–LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Expenses	–223782.86	–314745.36	–329125.48	–344224.61	–360078.70	–376725.49	–394204.63
Revenues	17432.70	26470.00	28720.00	31720.00	33220.00	34220.00	35220.00
Avoided Costs	48957.88	124020.00	145980.00	170214.00	177276.00	180090.00	180297.00
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	–157392.28	–164255.36	–154425.48	–142290.61	–149582.70	–162415.49	–178687.63
Cost/ton	126.99	70.19	63.47	55.17	57.38	62.23	68.38

NET COST/BENEFIT
MID–LEVEL PRICING, MODDERATELY INCREASING TIPPING FEES

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Expenses	–223782.86	–314745.36	–329125.48	–344224.61	–360078.70	–376725.49	–394204.63
Revenues	30580.75	51350.00	55600.00	61380.00	63620.00	64860.00	66100.00
Avoided Costs	48957.88	124020.00	145980.00	170214.00	177276.00	180090.00	180297.00
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	–144244.23	–139375.36	–127545.48	–112630.61	–119182.70	–131775.49	–147807.63
Cost/ton	116.38	59.56	52.42	43.67	45.72	50.49	56.57

NET COST/BENEFIT
HIGH–LEVEL PRICING, MOODERATELY INCREASING TIPPING FEES

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Expenses	–223782.86	–314745.36	–329125.48	–344224.61	–360078.70	–376725.49	–394204.63
Revenues	48266.15	86250.00	92640.00	101240.00	104700.00	106160.00	107620.00
Avoided Costs	48957.88	124020.00	145980.00	170214.00	177276.00	180090.00	180297.00
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	–126558.83	–104475.36	–90505.48	–72770.61	–78102.70	–90475.49	–106287.63
Cost/ton	102.11	44.65	37.20	28.22	29.96	34.66	40.68

FIGURE 8

SCENARIO TWO: INCREASED COOPERATION

NET COST/BENEFIT
LOW-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-223782.86	-314745.36	-329125.48	-344224.61	-360078.70	-376725.49	-394204.63
Revenues	17432.70	26470.00	28720.00	31720.00	33220.00	34220.00	35220.00
Avoided Costs	48957.88	95940.00	103402.50	113476.00	118618.50	122670.00	126730.50
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-157392.28	-192335.36	-197002.98	-199028.61	-208240.20	-219835.49	-232254.13
Cost/ton	126.99	82.19	80.97	77.17	79.88	84.23	88.88

NET COST/BENEFIT
MID-LEVEL PRICIING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-223782.86	-314745.36	-329125.48	-344224.61	-360078.70	-376725.49	-394204.63
Revenues	30580.75	51350.00	55600.00	61380.00	63620.00	64860.00	66100.00
Avoided Costs	48957.88	95940.00	103402.50	113476.00	118618.50	122670.00	126730.50
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-144244.23	-167455.36	-170122.98	-169368.61	-177840.20	-189195.49	-201374.13
Cost/ton	116.38	71.56	69.92	65.67	68.22	72.49	77.07

NET COST/BENEFIT
HIGH LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-223782.86	-314745.36	-329125.48	-344224.61	-360078.70	-376725.49	-394204.63
Revenues	48266.15	86250.00	92640.00	101240.00	104700.00	106160.00	107620.00
Avoided Costs	48957.88	95940.00	103402.50	113476.00	118618.50	122670.00	126730.50
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-126558.83	-132555.36	-133082.98	-129508.61	-136760.20	-147895.49	-159854.13
Cost/ton	102.11	56.65	54.70	50.22	52.46	56.66	61.18

FIGURE 9

SCENARIO TWO: INCREASED COOPERATION

SANITATION COSTS

Waste generation (in tons).

Area	93–94	94–95	95–96	96–97	97–98	98–99	99–00
University	5143.53	5400.71	5670.74	5954.28	6251.99	6564.59	6892.82
Medical Center	6346.07	6663.38	6996.55	7346.37	7713.69	8099.38	8504.35
Recycled Tons	−1239.44	−2340.00	−2433.00	−2579.00	−2607.00	−2610.00	−2613.00
Total landfilled	10250.16	9724.09	10234.29	10721.65	11358.68	12053.97	12784.17

Tipping Fees Paid Per Year: Moderate Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Total Fees	404881.32	515376.77	614057.40	707628.90	772390.24	831723.93	882107.73

Tipping Fees Paid Per Year: Slow Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Total Fees	404881.32	398687.69	434957.33	471752.60	516819.94	566536.59	620032.25

FIGURE 10

SCENARIO TWO: INCREASED COOPERATION

NET COST/BENEFIT SANITATION COSTS	MODERATELY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees	404881.32	515376.77	614057.40	707628.90	772390.24	831723.93	882107.73
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	929730.32	1066468.22	1192703.42	1315207.22	1410347.48	1501579.03	1585455.59
Cost/ton	90.70	109.67	116.54	122.67	124.16	124.57	124.02

NET COST/BENEFIT SANITATION COSTS	SLOWLY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees	404881.32	398687.69	434957.33	471752.60	516819.94	566536.59	620032.25
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	929730.32	949779.14	1013603.35	1079330.92	1154777.18	1236391.69	1323380.10
Cost/ton	90.70	97.67	99.04	100.67	101.66	102.57	103.52

FIGURE 11

SCENARIO TWO: INCREASED COOPERATION

COMBINED COST OF SANITATION AND RECYCLING

WEIGHTED AVERAGE COST/TON
LOW-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	109.67	116.54	122.67	124.16	124.57	124.02
Recycling Cost/ton	126.99	70.19	63.47	55.17	57.38	62.23	68.38
Weighted Avg. Cost/ton	94.62	102.01	106.35	109.58	111.70	113.48	114.58

MID-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	109.67	116.54	122.67	124.16	124.57	124.02
Recycling Cost/ton	116.38	59.56	52.42	43.67	45.72	50.49	56.57
Weighted Avg. Cost/ton	93.47	99.95	104.22	107.35	109.52	111.39	112.57

HIGH-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	109.67	116.54	122.67	124.16	124.57	124.02
Recycling Cost/ton	102.08	44.65	37.20	28.22	29.96	34.66	40.68
Weighted Avg. Cost/ton	91.93	97.06	101.30	104.35	106.58	108.57	109.87

The weighted average calculated above was calculated using the following formula:

$$\text{Weighted Average} = \frac{(\text{recycling cost/ton})(\text{no. of tons recycled}) + (\text{sanitation cost/ton})(\text{no. of tons landfilled})}{(\text{no. of tons recycled}) + (\text{no. of tons landfilled})}$$

FIGURE 12

SCENARIO TWO: INCREASED COOPERATION

COMBINED COST OF SANITATION AND RECYCLING

LOW-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	97.67	99.04	100.67	101.66	102.57	103.52
Recycling Cost/ton	126.99	82.19	80.97	77.17	79.80	84.23	88.88
Weighted Avg. Cost/ton	94.62	94.67	95.57	96.11	97.58	99.31	101.03

MID-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	97.67	99.04	100.67	101.66	102.57	103.52
Recycling Cost/ton	116.38	71.56	69.92	65.67	68.22	72.49	77.07
Weighted Avg. Cost/ton	93.47	92.61	93.45	93.88	95.42	97.22	99.03

HIGH-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sanitation Cost/ton	90.70	97.67	99.04	100.67	101.66	102.57	103.52
Recycling Cost/ton	102.11	56.65	54.70	50.22	52.46	56.66	61.18
Weighted Avg. Cost/ton	91.93	89.72	90.52	90.89	92.48	94.40	96.33

The weighted average calculated above was calculated using the following formula:

$$\text{Weighted Average} = \frac{(\text{recycling cost/ton})(\text{no. of tons recycled}) + (\text{sanitation cost/ton})(\text{no. of tons landfilled})}{(\text{no. of tons recycled}) + (\text{no. of tons landfilled})}$$

SCENARIO THREE: STRUCTURAL REORGANIZATION

Figures 13 through 18 on pages 31 through 36 and supporting figures and charts in the appendix develop the cost of operations in this scenario.

In this scenario, we have combined the two separate recycling programs and the solid waste management program into a single cost center under a major management structural reorganization. Such a merger would build on the strengths of each department and achieve greater efficiencies through the elimination of duplication of effort. Budgeting and planning could be closely coordinated.

The waste recovery totals for Duke Recycles and DUMC Recycle and Read are shown in Figures 14 and 15 in the Appendix. Combined tonnages are shown in Figure 15 in the Appendix. As in the previous scenarios, costs per ton using different tipping fees and different revenues are calculated. In this scenario, the overall per ton cost to the University for this combination of services using high level pricing and moderately increasing tipping fees (see Figure 15 on page 33) would drop from $96.18/ton in FY 93-94 to $80.84/ton in FY 1999-2000. Using low level pricing and low tipping fees, they drop as low as $80.88/ton in FY 96-97 before leveling off at $85.88/ton in FY 1999-2000 (see Figure 17 on page 35).

These costs/ton are significantly less than the previously projected costs for the more conventional approach to solid waste management from Scenarios One, Two and Four for each respective year. This is best demonstrated by Charts 1 and 2 in the Executive Summary.

We are assuming that this structural reorganization can be accomplished with minimal increase in annual budget amounts (in fact, we think it would ultimately decrease them), but would require a significant up front capital investment to implement the program. Our best estimate for such an investment would be around $500,000. Refer to Figure 18 on page 36.

FIGURE 13

SCENARIO THREE: STRUCTURAL REORGANIZATION

REVENUES BASED ON LOW-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	10.00	2432.70	6800.00	12000.00	18000.00	18000.00	18000.00	18000.00
News	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White	20.00	3260.00	7520.00	16000.00	24000.00	24000.00	24000.00	24000.00
CPO	120.00	2400.00	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00
Mixed Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glass	15.00	2340.00	3750.00	7500.00	12000.00	12000.00	12000.00	12000.00
Aluminum	500.00	7000.00	8000.00	15000.00	22500.00	22500.00	22500.00	22500.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		17432.70	30870.00	55300.00	81300.00	81300.00	81300.00	81300.00

REVENUES BASED ON MID-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	15.00	3649.05	10200.00	18000.00	27000.00	27000.00	27000.00	27000.00
News	5.00	730.00	2500.00	4500.00	4500.00	4500.00	4500.00	4500.00
White	40.00	6520.00	15040.00	32000.00	48000.00	48000.00	48000.00	48000.00
CPO	150.00	3000.00	12000.00	12000.00	12000.00	12000.00	12000.00	12000.00
Mixed Paper	10.00	3551.70	9500.00	18000.00	18000.00	18000.00	18000.00	18000.00
Glass	30.00	4680.00	7500.00	15000.00	24000.00	24000.00	24000.00	24000.00
Aluminum	600.00	8400.00	9600.00	18000.00	27000.00	27000.00	27000.00	27000.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	40.00	40.00	520.00	4080.00	7200.00	7200.00	10800.00	18000.00
Tin	10.00	10.00	30.00	400.00	400.00	400.00	400.00	400.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		30580.75	66890.00	121980.00	168100.00	168100.00	171700.00	178900.00

REVENUES BASED ON HIGH-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	35.00	8514.45	23800.00	42000.00	63000.00	63000.00	63000.00	63000.00
News	15.00	2190.00	7500.00	13500.00	13500.00	13500.00	13500.00	13500.00
White	80.00	13040.00	30080.00	64000.00	96000.00	96000.00	96000.00	96000.00
CPO	240.00	4800.00	19200.00	19200.00	19200.00	19200.00	19200.00	19200.00
Mixed Paper	10.00	3551.70	9500.00	18000.00	18000.00	18000.00	18000.00	18000.00
Glass	40.00	6240.00	10000.00	20000.00	32000.00	32000.00	32000.00	32000.00
Aluminum	700.00	9800.00	11200.00	21000.00	31500.00	31500.00	31500.00	31500.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	60.00	60.00	780.00	6120.00	10800.00	10800.00	16200.00	27000.00
Tin	70.00	70.00	210.00	2800.00	2800.00	2800.00	2800.00	2800.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		48266.15	112270.00	206620.00	286800.00	286800.00	292200.00	303000.00

FIGURE 14

SCENARIO THREE: STRUCTURAL REORGANIZATION

EXPENSES Item	MODERATELY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
CONTINUED EXPENSE ITEMS FROM RECYCLING BUDGETS:							
Personnel	175504.00	232279.20	243893.16	256087.82	268892.21	282336.82	296453.66
Fringe	14759.00	25096.95	26351.80	27669.39	29052.86	30505.50	32030.77
Auto M&R	4200.00	4410.00	4630.50	4862.03	5105.13	5360.38	5628.40
Bins	6180.00	6489.00	6813.45	7154.12	7511.83	7887.42	8281.79
Education/Publicity	2590.00	25000.00	26250.00	27562.50	28940.63	30387.66	31907.04
Depreciation	9800.00	10290.00	10804.50	11344.73	11911.96	12507.56	13132.94
Other	8607.00	9037.35	9489.22	9963.68	10461.86	10984.96	11534.20
CONTINUED EXPENSE ITEMS FROM SANITATION BUDGET							
Tipping Fees	406856.48	478011.46	326897.30	283051.09	319850.61	366525.91	404696.61
Personnel/Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Depreciation	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Additional Depreciation*	0	40714.29	40714.29	40714.29	40714.29	40714.29	40714.29
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Total	1153345.48	1382419.70	1274490.24	1275987.95	1360398.61	1457065.59	1547727.56

FIGURE 15

SCENARIO THREE: STRUCTURAL REORGANIZATION

NET COST/BENEFIT
LOW-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1382419.70	-1274490.24	-1275987.95	-1360398.61	-1457065.59	-1547727.56
Revenues	17432.70	30870.00	55300.00	81300.00	81300.00	81300.00	81300.00
Net	-1135912.78	-1351549.70	-1219190.24	-1194687.95	-1279098.61	-1375765.59	-1466427.56
Cost/ton	98.86	112.03	96.25	89.82	91.59	93.82	95.24

NET COST/BENEFIT
MID-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1382419.70	-1274490.24	-1275987.95	-1360398.61	-1457065.59	-1547727.56
Revenues	30580.75	66890.00	121980.00	168100.00	168100.00	171700.00	178900.00
Net	-1122764.73	-1315529.70	-1152510.24	-1107887.95	-1192298.61	-1285365.59	-1368827.56
Cost/ton	97.72	109.05	90.98	83.30	85.37	87.65	88.90

NET COST/BENEFIT
HIGH-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1382419.70	-1274490.24	-1275987.95	-1360398.61	-1457065.59	-1547727.56
Revenues	48266.15	112270.00	206620.00	286800.00	286800.00	292200.00	303000.00
Net	-1105079.33	-1270149.70	-1067870.24	-989187.95	-1073598.61	-1164865.59	-1244727.56
Cost/ton	96.18	105.28	84.30	74.37	76.87	79.44	80.84

FIGURE 16

SCENARIO THREE: STRUCTURAL REORGANIZATION

EXPENSES Item	SLOWLY INCREASING TIPPING FEES 93-94	94-95	95-96	96-97	97-98	98-99	99-00
CONTINUED EXPENSE ITEMS FROM RECYCLING BUDGET							
Personnel	175504.00	232279.20	243893.16	256087.82	268892.21	282336.82	296453.66
Fringe	14759.00	25096.95	26351.80	27669.39	29052.86	30505.50	32030.77
Auto.	4200.00	4410.00	4630.50	4862.03	5105.13	5360.38	5628.40
Bins	6180.00	6489.00	6813.45	7154.12	7511.83	7887.42	8281.79
Publicity	2590.00	2719.50	2855.48	2998.25	3148.16	3305.57	3470.85
Depreciation	9800.00	10290.00	10804.50	11344.73	11911.96	12507.56	13132.94
Other	8607.00	9037.35	9489.22	9963.68	10461.86	10984.96	11534.20
CONTINUE EXPENSE ITEMS FROM SANTITATION BUDGET							
Tipping Fees	406856.48	369782.45	231552.26	188700.72	214017.69	249662.58	284460.66
Personnel/Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Depreciation	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Additional Depreciation*	0	40714.29	40714.29	40714.29	40714.29	40714.29	40714.29
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Total	1153345.48	1251910.19	1155750.67	1157073.34	1228773.22	1313120.17	1399055.42

FIGURE 17

SCENARIO THREE: STRUCTURAL REORGANIZATION

NET COST/BENEFIT
LOW-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1251910.19	-1155750.67	-1157073.34	-1228773.22	-1313120.17	-1399055.42
Revenues	17432.70	30870.00	55300.00	81300.00	81300.00	81300.00	81300.00
Net	-1135912.78	-1221040.19	-1100450.67	-1075773.34	-1147473.22	-1231820.17	-1317755.42
Cost/ton	98.86	101.21	86.87	80.88	82.16	84.00	85.58

NET COST/BENEFIT
MID-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1251910.19	-1155750.67	-1157073.34	-1228773.22	-1313120.17	-1399055.42
Revenues	30580.75	66890.00	121980.00	168100.00	168100.00	171700.00	178900.00
Net	-1122764.73	-1185020.19	-1033770.67	-988973.34	-1060673.22	-1141420.17	-1220155.42
Cost/ton	97.72	98.23	81.61	74.36	75.95	77.84	79.25

NET COST/BENEFIT
HIGH-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-1153345.48	-1251910.19	-1155750.67	-1157073.34	-1228773.22	-1313120.17	-1399055.42
Revenues	48266.15	112270.00	206620.00	286800.00	286800.00	292200.00	303000.00
Net	-1105079.33	-1139640.19	-949130.67	-870273.34	-941973.22	-1020920.17	-1096055.42
Cost/ton	96.18	94.47	74.93	65.43	67.45	69.62	71.19

FIGURE 18

SCENARIO THREE: STRUCTURAL REORGANIZATION

Under Scenario Three, the University would handle its waste in an entirely different manner. We believe most of the operational expense could be handled under the current budget structure. However, Scenario Three would require a significant investment in capital equipment. Although, it is likely that some of the current capital items could be replaced by recycling or composting equipment, we have not deleted any current capital items (e.g. front-loading garbage trucks).

ADDITIONAL START-UP EXPENSE

Facility Modifications	60000
Two trucks	160000
Roll-out carts	60000
Bins	30000
Compost turner	30000
Trommel	75000
Tractor	30000
Grinder	35000
Total	480000

• DEPRECIATION ON ADDITIONAL EQUIPMENT

Two trucks	160000
Compost turner	30000
tractor	30000
grinder	35000
trommel	75000
acquisition cost	330000

cost of equipment	330000
life in years	7
salvage	45000
annual depreciation	40714.29

PERSONNEL
Personnel costs under the recycling section are the same as listed in scenario 2.

OTHER:
When a composting program is instituted, the University will purchase fewer soil admendments. We did not figure the cost savings created by the production of in-house admendments through composting, because the value of such products is highly speculative at this time.

SCENARIO FOUR: NO RECYCLING

Scenario Four is the "go back to square one" scenario. The information contained in Figures 19 and 20 on the following pages is self-explanatory. This long term cost of this scenario is also demonstrated by the two line charts in the Executive Summary, pages iii and iv. Solid waste management costs would be impacted directly by increased or decreased tipping fees, and there would be no incremental "opportunity" costs for recycling as is considered in the other scenarios.

Due to the regulatory climate in the State of North Carolina and the well established recovery programs in existence at Duke, we do not consider this to be the University's best long term scenario for solid waste management.

FIGURE 19

SCENARIO FOUR: NO RECYCLING

Waste Disposed of in Tons:

Area	93–94	94–95	95–96	96–97	97–98	98–99	99–00
University	5143.53	5400.71	5670.74	5954.28	6251.99	6564.59	6892.82
Medical Center	6346.07	6663.38	6996.55	7346.37	7713.69	8099.38	8504.35
Totals	11489.6	12064.09	12667.29	13300.65	13965.68	14663.97	15397.17

Tipping Fees Paid Per Year: Moderate Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Total Fees	453839.20	639396.77	760037.40	877842.90	949666.24	1011813.93	1062404.73

Tipping Fees Paid Per Year: Slow Rate Increase

	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Tip Fee	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Total Fees	453839.20	494627.69	538359.83	585228.60	635438.44	689206.59	746762.75

FIGURE 20

SCENARIO FOUR: NO RECYCLING

NET COST/BENEFIT SANITATION COSTS	MODERATELY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees	453839.20	639396.77	760037.40	877842.90	949666.24	1011813.93	1062404.73
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center Containers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	978688.20	1190488.22	1338683.42	1485421.22	1587623.48	1681669.03	1765752.59
Cost/ton	85.18	98.68	105.68	111.68	113.68	114.68	114.68

NET COST/BENEFIT SANITATION COSTS	SLOWLY INCREASING TIPPING FEES 93–94	94–95	95–96	96–97	97–98	98–99	99–00
Personnel and Fringe	199289.00	209253.45	219716.12	230701.93	242237.03	254348.88	267066.32
Auto M&R	50000.00	52500.00	55125.00	57881.25	60775.31	63814.08	67004.78
Betterments	120000.00	126000.00	132300.00	138915.00	145860.75	153153.79	160811.48
Fuel	27100.00	28455.00	29877.75	31371.64	32940.22	34587.23	36316.59
Tipping Fees	453839.20	494627.69	538359.83	585228.60	635438.44	689206.59	746762.75
Other	52920.00	55566.00	58344.30	61261.52	64324.59	67540.82	70917.86
Containers	60540.00	63567.00	66745.35	70082.62	73586.75	77266.09	81129.39
Med. Center CoContainers	15000.00	15750.00	16537.50	17364.38	18232.59	19144.22	20101.43
Totals	978688.20	1045719.14	1117005.85	1192806.92	1273395.68	1359061.69	1450110.60
Cost/ton	85.18	86.68	88.18	89.68	91.18	92.68	94.18

Note: Even though the waste stream grows at a rate of 5% per year in this Scenario, we did not budget additional equipment as there is significant over–capacity in the system right now. We also did not increase the number of FTEs in this Scenario, although it is likely that additional FTEs would be required to maximize the use of existing equipment.

IV. CONCLUSIONS AND RECOMMENDATIONS

1. Step up the recycling efforts at Duke University Medical Center (DUMC) immediately.

   The greatest opportunity for the recovery in the waste stream is at DUMC. The following materials are available in quantity in the DUMC waste stream:

   - cardboard
   - office paper
   - plastic
   - glass

   - There is sufficient solid waste management capacity and related space at DUMC which could be utilized for recovery services rather than disposal.

2. Implement and continue a comprehensive training program for students, faculty and staff which provides the necessary information to promote and facilitate a waste reduction and recycling effort. (We estimate that this alone will result in a 3-5% reduction in the waste stream). Include recycling program information in all University orientation programs for faculty, staff and students.

3. Duke has significant flexibility for developing markets for materials because it is a private institution. It also has its own in-house Sanitation Department. If all the waste handling entities work together, they can provide a more extensive and more economical recycling and waste handling service to the University community.

4. Utilize the knowledge of Duke faculty and staff in future planning. For instance, recycling facility design can be offered up to a mechanical/civil engineering class as a possible project. Compost studies can be done as projects by graduate students in the Biological Sciences.

5. Commitment is a key requirement. When a course of action is decided by the University, it must be communicated to all levels of management, and employees, that best management practices for solid waste, including waste reduction and recycling is a priority. Without the cooperation of employees at all levels, it becomes much more difficult to implement an extensive program.

6. Make it a goal to become a national leader in waste reduction as a viable means of institutional waste management. Duke has already committed itself to a

high profile task force (the Paper Task Force organized by EDF). Duke's participation in such a project makes action essential. Duke should set its sights high - an 80% reduction, while difficult, is not unattainable.

7. University staff, employees and students need to understand that Duke recycling programs are responsible for helping them recycle, not to recycle for them. Whether you recycle or dispose you still must handle, haul, or carry that material. Recycling is more difficult than throwing something away. If Duke is to successfully market recovered material, source separation is the key. Everyone at Duke must be counted upon to properly separate materials, thereby minimizing contamination.

8. Duke Recycles current facilities would be inadequate to accommodate growth. However, the area could be adapted with little difficulty.

9. There is no record of waste generated and disposed of by contractors during building projects. At the very least, some recycling of construction and demolition debris should be attempted and records should be maintained. We believe this could be up to 3,000 tons/year.

10. It is not realistic for Duke University to operate in Scenario Four due to the political, social, and financial commitments to recycling.

11. Scenario One, even at its maximum potential will not divert the 25-40% recycling goals as established by the Solid Waste Management Act of 1989.

12. Significant up front expenses will be incurred in Scenarios Two and Three.

13. The student labor force is an invaluable asset. Continue their involvement in the waste recovery programs.

14. Scenario Three can provide long term cost containment in managing solid waste for Duke University. It is recommended that implementation of Scenario Three be started immediately.

APPENDIX

CHART 1

RECYCLING TONNAGE 1989 – 1993

DUKE RECYCLES

Material	89–90	90–91	91–92	92–93
Cardboard	5.23	27.02	48.73	54.72
News	31.76	104.00	123.75	134.52
White	13.27	54.24	69.27	88.81
Blend	14.27	45.54	66.65	95.35
Aluminum	2.00	8.57	13.19	13.53
CPO	2.40	7.78	8.67	11.89
Glass	0.00	20.36	76.14	109.40
Scrap Metal	0.00	48.68	66.29	66.60
Other	15.01	74.28	28.24	49.39
TOTALS	83.94	390.47	500.93	624.21

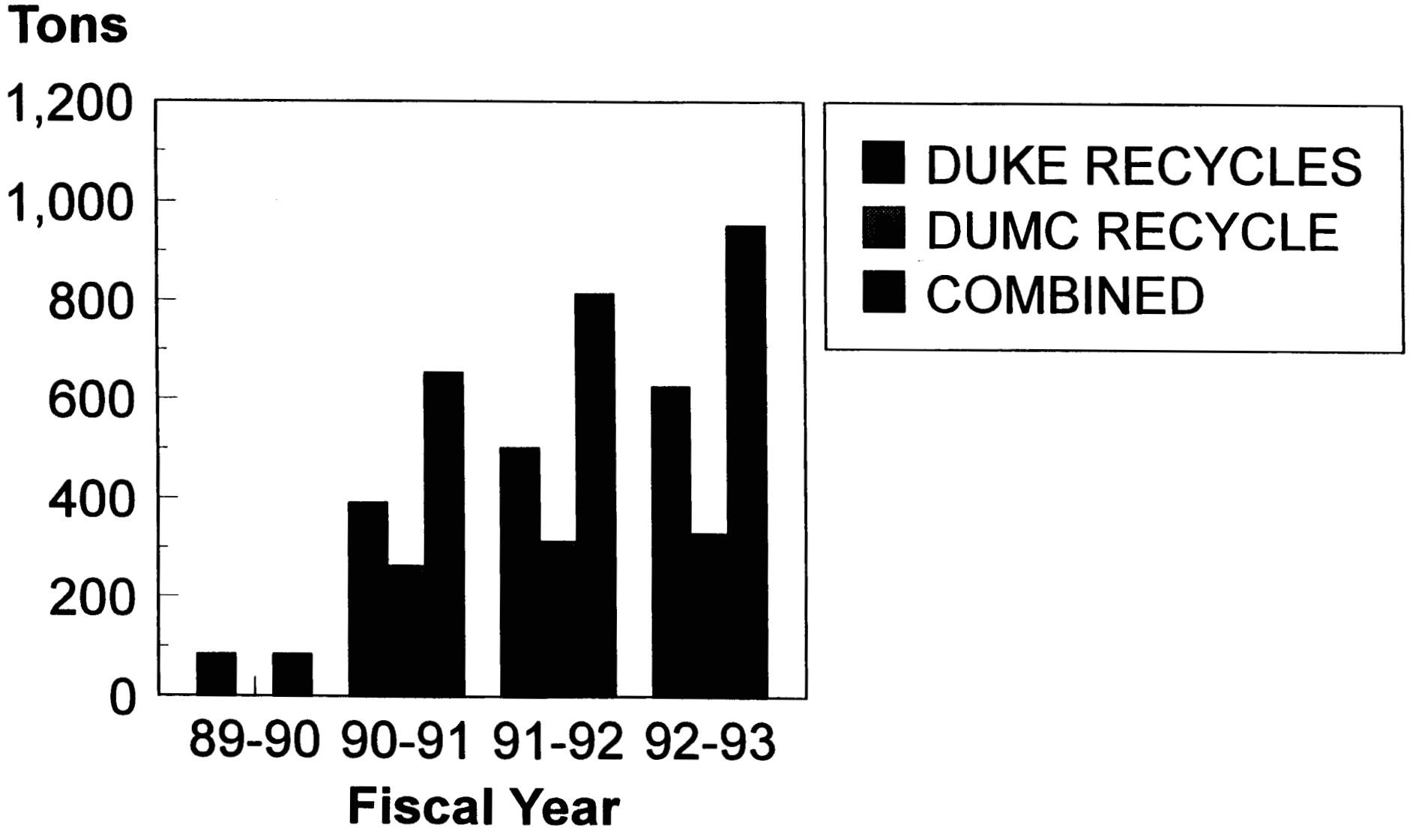
DUMC RECYCLE AND READ

Material	89–90	90–91	91–92	92–93
Cardboard		108.69	149.27	143.27
Blend		146.79	163.14	175.17
Aluminum		0.67	0.00	0.00
Other		5.66	0.00	10.00
TOTALS		262.01	312.41	328.44
GRAND TOTALS	83.94	652.48	813.34	952.65

Appendix Chart 2

History of Recycling

University and Medical Center/Hospital



APPENDIX

FIGURE 1

University (non-Medical) Projected Waste Stream

Material	%	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Total Tons		4898.60	5143.53	5400.71	5670.74	5954.28	6251.99	6564.59	6892.82
Cardboard	15.00%	734.79	771.53	810.11	850.61	893.14	937.80	984.69	1033.92
News	15.00%	734.79	771.53	810.11	850.61	893.14	937.80	984.69	1033.92
White	10.00%	489.86	514.35	540.07	567.07	595.43	625.20	656.46	689.28
CPO	1.00%	48.99	51.44	54.01	56.71	59.54	62.52	65.65	68.93
Mixed Paper	25.00%	1224.65	1285.88	1350.18	1417.69	1488.57	1563.00	1641.15	1723.21
Glass	6.00%	293.92	308.61	324.04	340.24	357.26	375.12	393.88	413.57
Aluminum	1.50%	73.48	77.15	81.01	85.06	89.31	93.78	98.47	103.39
Scrap	3.00%	146.96	154.31	162.02	170.12	178.63	187.56	196.94	206.78
Plastic	2.00%	97.97	102.87	108.01	113.41	119.09	125.04	131.29	137.86
Tin	1.00%	48.99	51.44	54.01	56.71	59.54	62.52	65.65	68.93
Other	20.50%	1004.21	1054.42	1107.15	1162.50	1220.63	1281.66	1345.74	1413.03
Total	100.00%	4898.60	5143.53	5400.71	5670.74	5954.28	6251.99	6564.59	6892.82

Note: These percentages are a composite of numbers available in the literature and our own observations. Mixed paper includes office fiber, blend paper, magazines and other low-grade papers.

APPENDIX

FIGURE 2

Medical Center/Hospital Projected Waste Stream

Material	%	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Total Tons		6043.88	6346.07	6663.38	6996.55	7346.37	7713.69	8099.38	8504.35
Cardboard	21.00%	1269.21	1332.67	1399.31	1469.28	1542.74	1619.87	1700.87	1785.91
News	5.20%	314.28	330.00	346.50	363.82	382.01	401.11	421.17	442.23
White	14.70%	888.45	932.87	979.52	1028.49	1079.92	1133.91	1190.61	1250.14
CPO	1.00%	60.44	63.46	66.63	69.97	73.46	77.14	80.99	85.04
Mixed paper	10.40%	628.56	659.99	692.99	727.64	764.02	802.22	842.34	884.45
Glass	9.00%	543.95	571.15	599.70	629.69	661.17	694.23	728.94	765.39
Aluminum	2.00%	120.88	126.92	133.27	139.93	146.93	154.27	161.99	170.09
Food	14.00%	846.14	888.45	932.87	979.52	1028.49	1079.92	1133.91	1190.61
Plastic	10.50%	634.61	666.34	699.65	734.64	771.37	809.94	850.43	892.96
Other	12.20%	737.35	774.22	812.93	853.58	896.26	941.07	988.12	1037.53
Total	100.00%	6043.880	6346.07	6663.38	6996.55	7346.37	7713.69	8099.38	8504.35

Notes: The waste composition percentages for this chart were taken from the Prete–Wilmot study. Low–grade paper was broken into mixed paper and newspaper so as to be comparable with the university's figures.

APPENDIX

CHART 3

WASTE COMPOSITION: DUKE UNIVERSITY

UNIVERSITY

Material	Percentage
Cardboard	15.00%
News	15.00%
White	10.00%
CPO	1.00%
Mixed Paper	25.00%
Glass	6.00%
Aluminum	1.50%
Scrap Metal	3.00%
Plastic	2.00%
Tin	1.00%
Other	20.50%
	100.00%

MEDICAL CENTER/HOSPITAL

Material	Percentage
Cardboard	21.00%
News	5.20%
White	14.70%
CPO	1.00%
Mixed Paper	10.40%
Glass	9.00%
Aluminum	2.00%
Food	14.00%
Plastic	10.50%
Tin	0.00%
Other	12.20%
	100.00%

APPENDIX

FIGURE 3 SOLID WASTE HISTORY DUKE UNIVERSITY

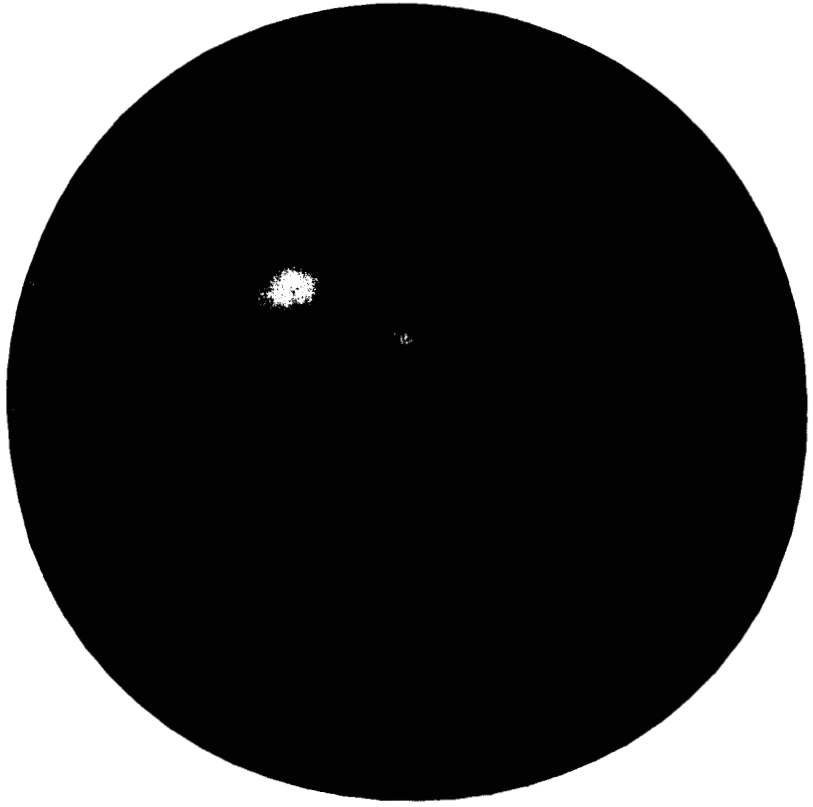
MONTH		86-87	87-88	88-89	89-90	90-91	91-92	92-93	AVG.
JUL	LANDFILLED	690.00	790.00	975.00	961.00	833.00	808.00	788.00	835.00
	RECYCLED	0.00	0.00	0.00	0.00	34.19	60.32	50.89	36.35
	TOTAL	690.00	790.00	975.00	961.00	867.19	868.32	838.89	855.77
AUG	LANDFILLED	960.00	990.00	964.00	951.00	817.00	796.00	771.00	892.71
	RECYCLED	0.00	0.00	0.00	0.00	47.43	58.55	57.35	40.83
	TOTAL	960.00	990.00	964.00	951.00	864.43	854.55	828.35	916.05
SEPT	LANDFILLED	970.00	970.00	914.00	972.00	979.00	831.00	880.00	930.86
	RECYCLED	0.00	0.00	0.00	0.00	56.15	59.82	73.48	47.36
	TOTAL	970.00	970.00	914.00	972.00	1035.15	890.82	953.48	957.92
OCT	LANDFILLED	810.00	890.00	916.00	947.00	837.00	921.00	957.00	896.86
	RECYCLED	0.00	0.00	0.00	0.00	54.93	66.46	93.98	53.84
	TOTAL	810.00	890.00	916.00	947.00	891.93	987.46	1050.98	927.62
NOV	LANDFILLED	760.00	810.00	783.00	770.00	706.00	786.00	843.00	779.71
	RECYCLED	0.00	0.00	0.00	0.00	48.53	71.34	90.96	52.71
	TOTAL	760.00	810.00	783.00	770.00	754.53	857.34	933.96	809.83
DEC	LANDFILLED	790.00	925.00	856.00	947.00	871.00	699.00	739.00	832.43
	RECYCLED	0.00	0.00	0.00	0.00	73.62	53.20	63.83	47.66
	TOTAL	790.00	925.00	856.00	947.00	944.62	752.20	802.83	859.66
JAN	LANDFILLED	925.00	1014.00	892.00	907.00	776.00	863.00	746.00	874.71
	RECYCLED	0.00	0.00	0.00	0.00	45.86	52.00	74.49	43.09
	TOTAL	925.00	1014.00	892.00	907.00	821.86	915.00	820.49	899.34
FEB	LANDFILLED	910.00	1045.00	1078.00	878.00	804.00	787.00	775.00	896.71
	RECYCLED	0.00	0.00	0.00	0.00	51.38	85.42	93.70	57.63
	TOTAL	910.00	1045.00	1078.00	878.00	855.38	872.42	868.70	929.64
MARCH	LANDFILLED	960.00	973.00	943.00	899.00	916.00	804.00	892.00	912.43
	RECYCLED	0.00	0.00	0.00	20.98	69.17	82.94	66.11	59.80
	TOTAL	960.00	973.00	943.00	919.98	985.17	886.94	958.11	946.60
APRIL	LANDFILLED	865.00	925.00	971.00	899.00	890.00	878.00	885.00	901.86
	RECYCLED	0.00	0.00	0.00	20.98	66.93	74.14	101.18	65.81
	TOTAL	865.00	925.00	971.00	919.98	956.93	952.14	986.18	939.46
MAY	LANDFILLED	736.00	951.00	844.00	972.00	715.00	897.00	886.00	857.29
	RECYCLED	0.00	0.00	0.00	20.98	54.21	59.00	97.08	57.82
	TOTAL	736.00	951.00	844.00	992.98	769.21	956.00	983.08	890.32
JUNE	LANDFILLED	790.00	737.00	764.00	756.00	715.00	795.00	838.00	770.71
	RECYCLED	0.00	0.00	0.00	21.00	50.08	90.15	89.60	62.71
	TOTAL	790.00	737.00	764.00	777.00	765.08	885.15	927.60	806.55
TOTAL LANDFILLED		10166.00	11020.00	10900.00	10859.00	9859.00	9865.00	10000.00	10381.29
TOTAL RECYCLED		0.00	0.00	0.00	83.94	652.48	813.34	952.65	357.49
TOTAL SOLID WASTE		10166.00	11020.00	10900.00	10942.94	10511.48	10678.34	10952.65	10738.77

(ALL FIGURES ARE IN TONS.)

Appendix Chart 4

Duke University Waste Stream by Area

University 44.8%

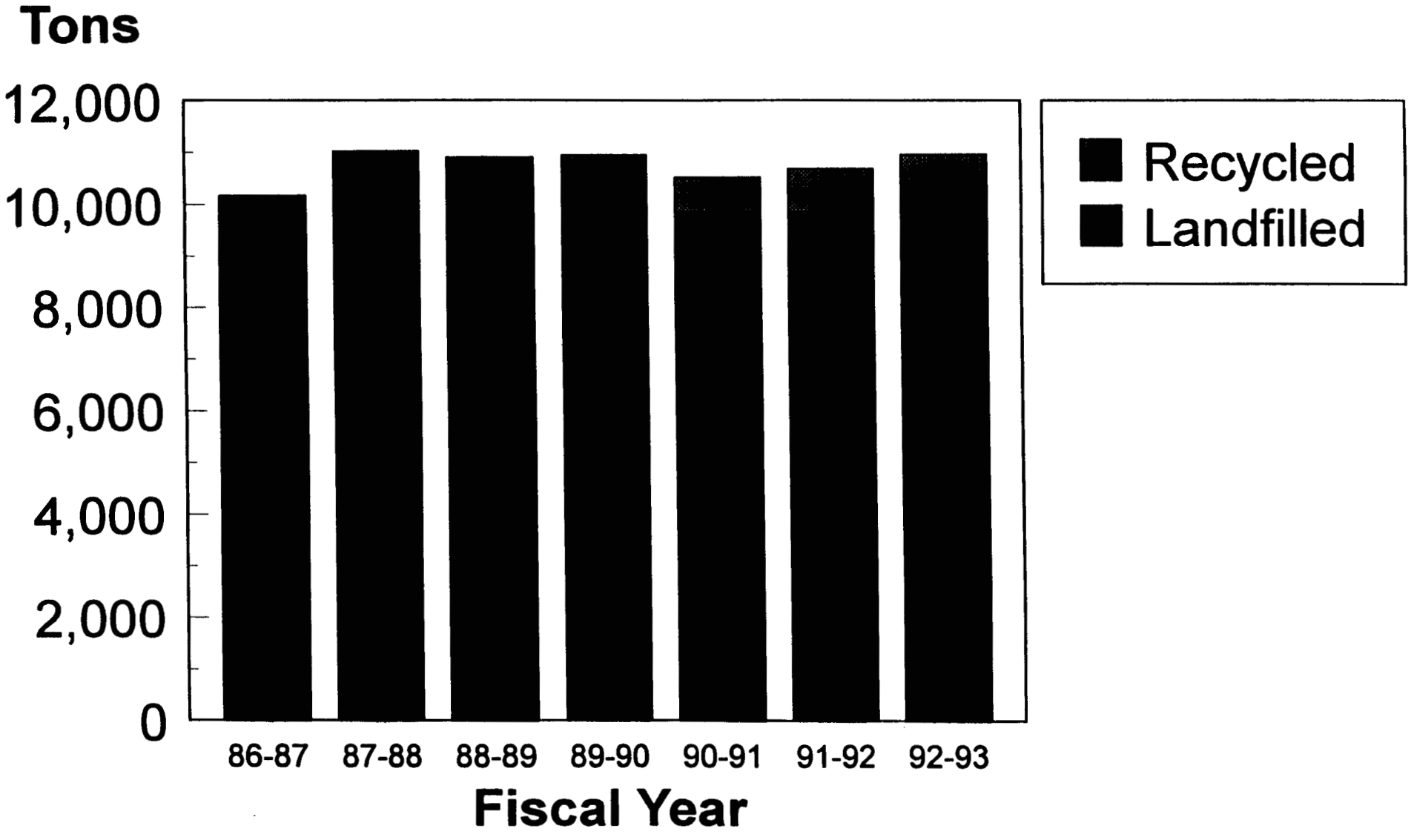


Medical/Hosp. 55.2%

Appendix Chart 5

Solid Waste History Duke University

FY 86-87 to FY 92-93



APPENDIX

FIGURE 4

DUKE RECYCLES: NET COSTS FY 89-90 TO FY 93-94
(In dollars).

	89-90	90-91	91-92*	92-93	93-94
Expenses	-61278.00	-66221.21	-62460.01	-108693.49	-135700.00
Revenues	3808.24	21137.41	20468.73	19934.49	25543.00
Avoided Costs	1091.22	5076.11	13024.18	23719.98	32034.50
(Tip Fee)	(13.00)	(13.00)	(26.00)	(38.00)	(39.50)
Net cost	-56378.54	-40007.69	-28967.10	-65039.02	-78122.50
Tons	83.94	390.47	500.93	624.21	811.00
Cost/ton	671.65	102.46	57.83	104.19	96.33

* Some of the labor costs for DUKE RECYCLES in FY 91-92 were paid for out of the Surplus Store's budget.

DUMC RECYCLE AND READ: NET COSTS FY 89-90 TO FY 93-94

	89-90	90-91	91-92	92-93	93-94
Expenses	N/A	-85940.00	-85940.00	-85940.00	-85940.00
Revenues	N/A	7625.20	1999.05	1452.80	1500.00
Avoided Costs	N/A	3406.13	8122.66	12480.72	14948.38
Net Cost		-74908.67	-75818.29	-72006.48	-69491.62
Tons		262.01	312.41	328.44	378.44
Cost/ton		-285.90	242.69	219.24	183.63

(N/A= NOT AVAILABLE)

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SUMMARY ENTIRE UNIVERSITY

	89-90	90-91	91-92	92-93	93-94
Expenses	N/A	-152161.21	-148400.01	-194633.49	-221640.00
Revenue	N/A	28762.61	22467.78	21387.29	27043.00
Avoided Cost	N/A	8482.24	21146.84	36200.70	46982.88
Net Cost		-114916.36	-104785.39	-137045.50	-147614.12
Cost/ton		176.12	128.83	143.86	124.10

APPENDIX

FIGURE 5
TOTAL SOLID WASTE MANAGEMENT COSTS:
SANITATION, DUKE RECYCLES, DUMC RECYCLE AND READ

DEPT.	91–92	92–93	93–94*
Sanitation Expense	–647040.00	–754412.00	–931705.32
DUKE RECYCLES expense	–62460.01	–108693.49	–135700.00
DUMC Expense	–85940.00	–85940.00	–85940.00
GROSS	–795440.01	–949045.49	–1153345.32
Revenues	22467.78	21387.29	27043.00
Avoided Costs	21146.84	36200.70	46982.88
NET COSTS	–751825.39	–891457.50	–1079319.44

* Figures for 93–94 are budget projections.

Note: There is a direct correlation between rising tipping fees and sanitation costs.
The Sanitation budget listed above has been adjusted to reflect the fact that tipping fees increased to $39.50 in FY 93–94 and not $49 as originally budgeted.

Avoided costs are subtracted from the gross costs to account for tipping fees that would have been paid if recycling did not exist.

APPENDIX

CHART 6

POSSIBLE TIPPING FEE SCALES

SLOWLY INCREASING TIPPING FEES

FY	93–94	94–95	95–96	96–97	97–98	98–99	99–00
$/TON	39.50	41.00	42.50	44.00	45.50	47.00	48.50

MODERATELY INCREASING TIPPING FEES

FY	93–94	94–95	95–96	96–97	97–98	98–99	99–00
$/TON	39.50	53.00	60.00	66.00	68.00	69.00	69.00

APPENDIX

FIGURE 6

SCENARIO ONE: STATUS QUO

PROJECTED RECYCLED TONNAGE DUKE RECYCLES

Material	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	54.72	100.00	120.00	180.00	180.00	180.00	180.00	180.00
% of Mat. gen.	7.45%	12.96%	14.81%	21.16%	20.15%	19.19%	18.28%	17.41%
News	134.52	146.00	158.00	158.00	158.00	158.00	158.00	158.00
% of mat. gen.	18.31%	18.92%	19.50%	18.57%	17.69%	16.85%	16.05%	15.28%
White	88.81	113.00	138.00	138.00	138.00	138.00	138.00	138.00
% of mat. gen.	18.13%	21.97%	25.55%	24.34%	23.18%	22.07%	21.02%	20.02%
CPO	11.89	20.00	20.00	20.00	20.00	20.00	20.00	20.00
% of mat. gen.	24.27%	38.88%	37.03%	35.27%	33.59%	31.99%	30.46%	29.01%
Mixed	144.74	180.00	225.00	244.00	305.00	305.00	305.00	305.00
% of mat. gen.	11.82%	14.00%	16.66%	17.21%	20.49%	19.51%	18.58%	17.70%
Glass	109.40	156.00	170.00	170.00	170.00	170.00	170.00	170.00
% of mat. gen.	37.22%	50.55%	52.46%	49.96%	47.58%	45.32%	43.16%	41.11%
Aluminum	13.53	14.00	14.00	14.00	14.00	14.00	14.00	14.00
% of mat. gen.	18.41%	18.15%	17.28%	16.46%	15.68%	14.93%	14.22%	13.54%
Scrap	66.60	67.00	67.00	67.00	67.00	67.00	67.00	67.00
% of mat. gen.	45.32%	43.42%	41.35%	39.38%	37.51%	35.72%	34.02%	32.40%
Plastic	0.00	1.00	12.00	12.00	12.00	12.00	12.00	12.00
% of mat. gen.	0.00%	0.97%	11.11%	10.58%	10.08%	9.60%	9.14%	8.70%
Tin	0.00	1.00	3.00	6.00	12.00	12.00	12.00	12.00
% of mat.gen.	0.00%	1.94%	5.55%	10.58%	20.15%	19.19%	18.28%	17.41%
Other	0.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
% of mat. gen.	0.00	1.23%	1.17%	1.12%	1.07%	1.01%	0.97%	0.92%
Total tons	624.21	811.00	940.00	1022.00	1089.00	1089.00	1089.00	1089.00

Notes: Mixed paper includes office fiber, blend, magazines and other low-grade papers. For simplicity's sake these grades are all lumped under mixed paper.
Cardboard almost doubles for FY 93-94, because this material is being targeted this year.
As education efforts increase, we expect collections of all categories to increase. However, the maximum recoverable waste is facility-limited. These tonnages represent the staff's best estimate of potential recovery.

APPENDIX

FIGURE 7

SCENARIO ONE: STATUS QUO DUMC RECYCLE AND READ

PROJECTED RECYCLED TONNAGE

Material	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	143.27	143.27	143.27	143.27	143.27	143.27	143.27	143.27
% of Mat. gen.	11.29%	10.75%	10.24%	9.75%	9.29%	8.84%	8.42%	8.02%
News	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
White	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CPO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Mixed	175.17	175.17	175.17	175.17	175.17	175.17	175.17	175.17
	27.87%	27.27%	25.28%	24.07%	22.93%	21.84%	20.80%	19.81%
Glass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Aluminum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Tin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat.gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
Other	10.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
% of mat. gen.	0.01	7.75%	7.38%	7.03%	6.69%	6.38%	6.07%	5.78%
Total tons	328.44	378.44	378.44	378.44	378.44	378.44	378.44	378.44

TOTAL TONS BOTH PROGRAMS

DUKE RECYCLES	624.21	811.00	940.00	1022.00	1089.00	1089.00	1089.00	1089.00
DUMC	328.44	378.44	378.44	378.44	378.44	378.44	378.44	378.44
TOTAL	952.65	1189.44	1318.44	1400.44	1467.44	1467.44	1467.44	1467.44

APPENDIX

FIGURE 8

SCENARIO ONE: STATUS QUO

REVENUES BASED ON LOW-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	10.00	2432.70	2632.70	3232.70	3232.70	3232.70	3232.70	3232.70
News	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White	20.00	2260.00	2760.00	2760.00	2760.00	2760.00	2760.00	2760.00
CPO	120.00	2400.00	2400.00	2400.00	2400.00	2400.00	2400.00	2400.00
Mixed Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glass	15.00	2340.00	2550.00	2550.00	2550.00	2550.00	2550.00	2550.00
Aluminum	500.00	7000.00	7000.00	7000.00	7000.00	7000.00	7000.00	7000.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		16432.70	17342.70	17942.70	17942.70	17942.70	17942.70	17942.70

REVENUES BASED ON MID-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	15.00	3649.05	3949.05	4849.05	4849.05	4849.05	4849.05	4849.05
News	5.00	730.00	790.00	790.00	790.00	790.00	790.00	790.00
White	40.00	4520.00	5520.00	5520.00	5520.00	5520.00	5520.00	5520.00
CPO	150.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00
Mixed Paper	10.00	3551.70	4001.70	4191.70	4801.70	4801.70	4801.70	4801.70
Glass	30.00	4680.00	5100.00	5100.00	5100.00	5100.00	5100.00	5100.00
Aluminum	600.00	8400.00	8400.00	8400.00	8400.00	8400.00	8400.00	8400.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	40.00	40.00	480.00	480.00	480.00	480.00	480.00	480.00
Tin	10.00	10.00	30.00	60.00	120.00	120.00	120.00	120.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		28580.75	31270.75	32390.75	33060.75	33060.75	33060.75	33060.75

REVENUES BASED ON HIGH-LEVEL PRICES FOR EACH MATERIAL

Material	$/ton	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	35.00	8514.45	9214.45	11314.45	11314.45	11314.45	11314.45	11314.45
News	15.00	2190.00	2370.00	2370.00	2370.00	2370.00	2370.00	2370.00
White	80.00	9040.00	11040.00	11040.00	11040.00	11040.00	11040.00	11040.00
CPO	240.00	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00	4800.00
Mixed Paper	10.00	3551.70	4001.70	4191.70	4801.70	4801.70	4801.70	4801.70
Glass	40.00	6240.00	6800.00	6800.00	6800.00	6800.00	6800.00	6800.00
Aluminum	700.00	9800.00	9800.00	9800.00	9800.00	9800.00	9800.00	9800.00
Scrap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	60.00	60.00	720.00	720.00	720.00	720.00	720.00	720.00
Tin	70.00	70.00	210.00	420.00	840.00	840.00	840.00	840.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		44266.15	48956.15	51456.15	52486.15	52486.15	52486.15	52486.15

APPENDIX

FIGURE 9

SCENARIO ONE: STATUS QUO
EXPENSES

Item	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Personnel	89564.00	94042.20	98744.31	103681.53	108865.60	114308.88	120024.33
DUMC Personnel	85940.00	90237.00	94748.85	99486.29	104460.61	109683.64	115167.82
Fringe	14759.00	15496.95	16271.80	17085.39	17939.66	18836.64	19778.47
Auto.	4200.00	4410.00	4630.50	4862.03	5105.13	5360.38	5628.40
Bins	6180.00	6489.00	6813.45	7154.12	7511.83	7887.42	8281.79
Publicity	2590.00	2719.50	2855.48	2998.25	3148.16	3305.57	3470.85
Depreciation	9800.00	10290.00	10804.50	11344.73	11911.96	12507.56	13132.94
Other	8607.00	9037.35	9489.22	9963.68	10461.86	10984.96	11534.20
Total	221640.00	232722.00	244358.10	256576.01	269404.81	282875.05	297018.80

Note: Expense figures are taken from the DUKE RECYCLES financial statement and from the Prete-Wilmot study for DUMC Recycle and Read. All figures are increased by 5% each year.

APPENDIX

FIGURE 10

SCENARIO ONE: STATUS QUO

NET COST/BENEFIT
LOW-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	16432.70	17342.70	17942.70	17942.70	17942.70	17942.70	17942.70
Avoided Costs	46982.88	69877.32	84026.40	96851.04	99785.92	101253.36	101253.36
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	-158224.42	-145501.98	-142389.00	-141782.27	-151676.19	-163678.99	-177822.74
Cost/ton	133.02	110.36	101.67	96.62	103.36	111.54	121.18

NET COST BENEFIT
MID-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	28580.75	31270.75	32390.75	33060.75	33060.75	33060.75	33060.75
Avoided Costs	46982.88	69877.32	84026.40	96851.04	99785.92	101253.36	101253.36
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	-146076.37	-131573.93	-127940.95	-126664.22	-136558.14	-148560.94	-162704.69
Cost/ton	122.81	99.80	91.36	86.32	93.06	101.24	110.88

NET COST/BENEFIT
HIGH-LEVEL PRICING, MODERATELY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	44266.15	48956.15	51456.15	52486.15	52486.15	52486.15	52486.15
Avoided Costs	46982.88	69877.32	84026.40	96851.04	99785.92	101253.36	101253.36
(Tip Fee/ton)	39.50	53.00	60.00	66.00	68.00	69.00	69.00
Net	-130390.97	-113888.53	-108875.55	-107238.82	-117132.74	-129135.54	-143279.29
Cost/ton	109.62	86.38	77.74	73.08	79.82	88.00	97.64

APPENDIX

FIGURE 11

SCENARIO ONE: STATUS QUO (CONTINUED)

NET COST/BENEFIT
LOW-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	16432.70	17342.70	17942.70	17942.70	17942.70	17942.70	17942.70
Avoided Costs	46982.88	54056.04	59518.70	64567.36	66768.52	68969.68	71170.84
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-158224.42	-161323.26	-166896.70	-174065.95	-184693.59	-195962.67	-207905.26
Cost/ton	133.02	122.36	119.17	118.62	125.86	133.54	141.68

NET COST/BENEFIT
MID-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	28580.75	31270.75	32390.75	33060.75	33060.75	33060.75	33060.75
Avoided Costs	46982.88	54056.04	59518.70	64567.36	66768.52	68969.68	71170.84
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-146076.37	-147395.21	-152448.65	-158947.90	-169575.54	-180844.62	-192787.21
Cost/ton	122.81	111.80	108.86	108.32	115.56	123.24	131.38

NET COST/BENEFIT
HIGH-LEVEL PRICING, SLOWLY INCREASING TIPPING FEES

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Expenses	-221640.00	-232722.00	-244358.10	-256576.01	-269404.81	-282875.05	-297018.80
Revenues	44266.15	48956.15	51456.15	52486.15	52486.15	52486.15	52486.15
Avoided Costs	46982.88	54056.04	59518.70	64567.36	66768.52	68969.68	71170.84
(Tip Fee/ton)	39.50	41.00	42.50	44.00	45.50	47.00	48.50
Net	-130390.97	-129709.81	-133383.25	-139522.50	-150150.14	-161419.22	-173361.81
Cost/ton	109.62	98.38	95.24	95.08	102.32	110.00	118.14

APPENDIX

FIGURE 12

SCENARIO TWO: INCREASED COOPERATON

PROJECTED RECYCLED TONNAGE DUKE RECYCLES

Material	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	54.72	100.00	200.00	200.00	200.00	200.00	200.00	200.00
% of Mat. gen.	7.45%	12.96%	24.69%	23.51%	22.39%	21.33%	20.31%	19.34%
News	134.52	146.00	292.00	292.00	292.00	292.00	292.00	292.00
% of mat. gen.	18.31%	18.92%	36.04%	34.33%	32.69%	31.14%	29.65%	28.24%
White	88.81	113.00	276.00	276.00	276.00	276.00	276.00	276.00
% of mat. gen.	18.13%	21.97%	51.10%	48.67%	46.35%	44.15%	42.04%	40.04%
CPO	11.89	20.00	20.00	20.00	20.00	20.00	20.00	20.00
% of mat. gen.	24.27%	38.88%	37.03%	35.27%	33.59%	31.99%	30.46%	29.01%
Mixed	144.74	180.00	450.00	450.00	450.00	450.00	450.00	450.00
% of mat. gen.	11.82%	14.00%	33.33%	31.74%	30.23%	28.79%	27.42%	26.11%
Glass	109.40	156.00	200.00	200.00	200.00	200.00	200.00	200.00
% of mat. gen.	37.22%	50.55%	61.72%	58.78%	55.98%	53.32%	50.78%	48.36%
Aluminum	13.53	14.00	14.00	14.00	14.00	14.00	14.00	14.00
% of mat. gen.	18.41%	18.15%	17.28%	16.46%	15.68%	14.93%	14.22%	13.54%
Scrap	66.60	67.00	67.00	67.00	67.00	67.00	67.00	67.00
% of mat. gen.	45.32%	43.42%	41.35%	39.38%	37.51%	35.72%	34.02%	32.40%
Plastic	0.00	1.00	12.00	24.00	36.00	36.00	36.00	36.00
% of mat. gen.	0.00%	0.97%	11.11%	21.16%	30.23%	28.79%	27.42%	26.11%
Tin	0.00	1.00	3.00	6.00	12.00	12.00	12.00	12.00
% of mat.gen.	0.00%	1.94%	5.55%	10.58%	20.15%	19.19%	18.28%	17.41%
Other	0.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
% of mat. gen.	0.00	1.23%	1.17%	1.12%	1.07%	1.01%	0.97%	0.92%
Total tons	624.21	811.00	1547.00	1562.00	1580.00	1580.00	1580.00	1580.00

APPENDIX

FIGURE 13

SCENARIO TWO: INCREASED COOPERATION

PROJECTED RECYCLED TONNAGE DUMC RECYCLE AND READ

Material	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	143.27	143.27	280.00	280.00	280.00	280.00	280.00	280.00
% of Mat. gen.	11.29%	10.75%	20.01%	19.06%	18.15%	17.29%	16.46%	15.68%
News	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
% of mat. gen.	0.00%	0.00%	28.86%	27.49%	26.18%	24.93%	23.74%	22.61%
White	0.00	50.00	100.00	125.00	150.00	175.00	175.00	175.00
% of mat. gen.	0.00%	5.36%	10.21%	12.15%	13.89%	15.43%	14.70%	14.00%
CPO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mixed	175.17	175.17	200.00	200.00	200.00	200.00	200.00	200.00
	27.87%	26.54%	28.86%	27.49%	26.18%	24.93%	23.74%	22.61%
Glass	0.00	0.00	50.00	100.00	200.00	200.00	200.00	200.00
% of mat. gen.	0.00%	0.00%	8.34%	15.86%	30.25%	28.81%	27.44%	26.13%
Aluminum	0.00	0.00	2.00	4.00	6.00	8.00	10.00	12.00
% of mat. gen.	0.00%	0.00%	1.50%	2.86%	4.08%	5.19%	6.17%	7.06%
Food	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of mat. gen.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plastic	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
% of mat. gen.	0.00%	0.00%	0.14%	0.27%	0.39%	0.49%	0.59%	0.67%
Other	10.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
% of mat. gen.	1.36%	7.75%	7.38%	7.03%	6.69%	6.38%	6.07%	5.78%
Total tons	328.44	428.44	793.00	871.00	999.00	1027.00	1030.00	1033.00

TOTAL TONS BOTH PROGRAMS

University	624.21	811.00	1547.00	1562.00	1580.00	1580.00	1580.00	1580.00
DUMC	328.44	428.44	793.00	871.00	999.00	1027.00	1030.00	1033.00
Totals	952.65	1239.44	2340.00	2433.00	2579.00	2607.00	2610.00	2613.00

APPENDIX

FIGURE 14

SCENARIO THREE: STRUCTURAL REORGANIZATION

PROJECTED RECYCLED TONNAGE — DUKE RECYCLES

Material	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Cardboard	54.72	100.00	400.00	600.00	600.00	600.00	600.00	600.00
% of Mat. gen.	7.45%	0.13	0.49	0.71	0.67	0.64	0.61	0.58
News	134.52	146.00	400.00	600.00	600.00	600.00	600.00	600.00
% of mat. gen.	18.31%	0.19	0.49	0.71	0.67	0.64	0.61	0.58
White	88.81	113.00	276.00	400.00	400.00	400.00	400.00	400.00
% of mat. gen.	18.13%	0.22	0.51	0.71	0.67	0.64	0.61	0.58
CPO	11.89	20.00	40.00	40.00	40.00	40.00	40.00	40.00
% of mat. gen.	24.27%	0.39	0.74	0.71	0.67	0.64	0.61	0.58
Mixed	144.74	180.00	450.00	1100.00	1100.00	1100.00	1100.00	1100.00
% of mat. gen.	11.82%	0.14	0.33	0.78	0.74	0.70	0.67	0.64
Glass	109.40	156.00	200.00	300.00	300.00	300.00	300.00	300.00
% of mat. gen.	37.22%	0.51	0.62	0.88	0.84	0.80	0.76	0.73
Aluminum	13.53	14.00	14.00	20.00	25.00	25.00	25.00	25.00
% of mat. gen.	18.41%	0.18	0.17	0.24	0.28	0.27	0.25	0.24
Scrap	66.60	67.00	67.00	67.00	67.00	67.00	67.00	67.00
% of mat. gen.	45.32%	0.43	0.41	0.39	0.38	0.36	0.34	0.32
Plastic	0.00	1.00	12.00	90.00	90.00	90.00	90.00	90.00
% of mat. gen.	0.00%	0.01	0.11	0.79	0.76	0.72	0.69	0.65
Tin	0.00	1.00	3.00	40.00	40.00	40.00	40.00	40.00
% of mat.gen.	0.00%	0.02	0.06	0.71	0.67	0.64	0.61	0.58
Other	0.00	13.00	100.00	800.00	800.00	800.00	800.00	800.00
% of mat. gen.	0.00	0.01	0.09	0.69	0.66	0.62	0.59	0.57
Total tons	624.21	811.00	1962.00	4057.00	4062.00	4062.00	4062.00	4062.00

APPENDIX

FIGURE 15

SCENARIO THREE: STRUCTURAL REORGANIZATION

PROJECTED RECYCLED TONNAGE — DUMC RECYCLE AND READ

Material	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Cardboard	143.27	143.27	280.00	600.00	1200.00	1200.00	1200.00	1200.00
% of Mat. gen.	10.75%	0.11	0.20	0.41	0.78	0.74	0.71	0.67
News	0.00	0.00	100.00	300.00	300.00	300.00	300.00	300.00
% of mat. gen.	0.00%	0.00	0.29	0.82	0.79	0.75	0.71	0.68
White	0.00	50.00	100.00	400.00	800.00	800.00	800.00	800.00
% of mat. gen.	0.00%	0.05	0.10	0.39	0.74	0.71	0.67	0.64
CPO	0.00	0.00	40.00	40.00	40.00	40.00	40.00	40.00
% of mat. gen.	0.00%	0.00	0.60	0.57	0.54	0.52	0.49	0.47
Mixed	175.17	175.17	500.00	700.00	700.00	700.00	700.00	700.00
% of mat. gen.	26.54%	0.25	0.79	0.96	0.92	0.87	0.83	0.79
Glass	0.00	0.00	50.00	200.00	500.00	500.00	500.00	500.00
% of mat. gen.	0.00%	0.00	0.08	0.32	0.76	0.72	0.69	0.65
Aluminum	0.00	0.00	2.00	10.00	20.00	20.00	20.00	20.00
% of mat. gen.	0.00%	0.00	0.02	0.07	0.14	0.13	0.12	0.12
Food	0.00	0.00	0.00	700.00	800.00	800.00	800.00	800.00
% of mat. gen.	0.00	0.00	0.00	0.71	0.78	0.74	0.71	0.67
Plastic	0.00	0.00	1.00	12.00	90.00	90.00	180.00	360.00
% of mat. gen.	0.00%	0.00	0.00	0.02	0.12	0.11	0.21	0.40
Other	10.00	10.00	10.00	200.00	500.00	750.00	750.00	750.00
% of mat. gen.	1.36%	0.01	0.01	0.23	0.56	0.80	0.76	0.72
Total tons	328.44	378.44	1083.00	3162.00	4950.00	5200.00	5290.00	5470.00

TOTAL RECYCLED TONS	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
University	624.21	811.00	1962.00	4057.00	4062.00	4062.00	4062.00	4062.00
DUMC	328.44	378.44	1083.00	3162.00	4950.00	5200.00	5290.00	5470.00
Totals	952.65	1189.44	3045.00	7219.00	9012.00	9262.00	9352.00	9532.00

(These recovery rates assume that a compost program has been instituted.)_

TOTAL TONS LANDFILLED	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Total Avail.	10942.48	11489.60	12064.08	12667.29	13300.65	13965.69	14663.97	15397.17
Total Landfilled		10300.16	9019.08	5448.29	4288.65	4703.69	5311.97	5865.17

APPENDIX

FIGURE 16

SCENARIO COMPARSON CHART
(ALL FIGURES ARE IN DOLLARS/TON)

SCENARIO ONE	93–94	94–95	95–96	96–97	97–98	98–99	99–00
LOW, MOD	94.86	104.95	110.29	115.06	117.40	118.94	119.65
MID, MOD	93.80	103.79	109.15	113.92	116.31	117.91	118.67
HIGH, MOD	91.66	102.33	107.64	112.46	114.92	116.58	117.41
LOW, SLOW	94.86	95.57	96.66	97.91	99.62	101.34	103.06
MID, SLOW	93.80	95.18	95.52	96.78	98.54	100.31	102.08
HIGH, SLOW	92.44	92.95	94.01	95.32	97.15	98.98	100.82
SCENARIO TWO							
LOW, MOD	94.62	102.01	106.35	109.58	111.70	113.48	114.58
MID, MOD	93.47	99.59	104.22	107.35	109.52	111.39	112.57
HIGH, MOD	91.93	97.06	101.30	104.35	106.58	108.57	109.87
LOW, SLOW	94.62	94.67	95.57	96.11	97.58	99.31	101.03
MID, SLOW	93.47	92.61	93.45	93.88	95.42	97.22	99.03
HIGH, SLOW	91.93	89.72	90.52	90.89	92.48	94.40	96.33
SCENARIO THREE							
LOW, MOD	98.86	112.03	96.25	89.82	91.59	93.82	95.24
MID, MOD	97.72	109.05	90.98	83.30	85.37	87.65	88.90
HIGH, MOD	96.18	105.28	84.30	74.37	76.87	79.44	80.84
LOW, SLOW	98.86	101.21	86.87	80.88	82.16	84.00	85.58
MID, SLOW	97.72	98.23	81.61	74.36	75.95	77.84	79.25
HIGH. SLOW	96.18	94.47	74.93	65.45	67.62	69.62	71.19
SCENARIO FOUR							
MOD	85.18	98.68	105.68	111.68	113.68	114.68	114.68
SLOW	85.18	86.68	88.18	89.68	91.18	92.68	94.18

Notes: Cost/ton for Scenarios One and Two are weighted averges of sanitation and recycling costs.

LOW, MOD = Low–level prices, moderately increasing tipping fees
MID, MOD= Mid–level prices, moderately increasing tipping fees
HIGH, MOD= High–level prices, moderately increasing tipping fees

LOW, SLOW= Low–level prices, slowly incresing tipping fees
MID, SLOW= Mid–level prices, slowly increasing tipping fees
HIGH, SLOW= High–level prices, slowly increasing tipping fees

Landfill shortfall raising $2M stink with city's budget

By GREGORY CHILDRESS
The Herald-Sun

City officials won't be among those looking eagerly toward the new year.

That's because when 1994 rolls around, officials must have a plan in place to cover a revenue shortfall of nearly $2 million.

The shortfall recently turned up in the Solid Waste Management Fund, which accounts for revenues and expenses used to operate the city landfill.

City Manager Orville Powell said he will present the City Council with several options to defray the deficit at the council's Jan. 3 meeting.

He said one option might include cutting services. Recycling programs, yard waste collection, street cleaning are among the services paid out of the fund.

please see **SHORTFALL**/A2

SHORTFALL

The Herald Sun
FROM A1 Dec 22, 1993

"It's an option, but it's not one I'd be willing to recommend at this point," Powell said.

City officials said the shortfall was caused the Sanitation Department's failure to report credits due the city's commercial garbage collector, Browning Ferris Industries of South Atlantic Inc, to the Finance Department.

"We had two organizations that weren't communicating the way we wished they had," said Finance Director John Pedersen.

As a result, Pedersen said projected revenues for fiscal year 1993-94 were overestimated because they were based on erroneous projections for fiscal year 1992-93.

Pedersen said the problem actually sprouted in fiscal year 1991-92, but was not discovered until last summer during the start of a city audit. The problem was further exacerbated because no accounting system was in place to catch the misstep.

At least one council member says he is not satisfied with the explanation the city staff has given him about the shortfall.

"The extent of the problem indicates to me that we have some weak administrative structures in place," said newly elected Council Member Frank Hyman.

Hyman said he wants further explanation about how the shortfall came about and how such a large problem went undetected during the 1993-94 budget work sessions.

Other council members said they were largely in the dark about the shortfall and are waiting to hear the city manager's explanation.

"He [Powell] mentioned to me that there seemed to be this problem, but I don't know much about it overall," Kerckhoff said. "I know Orville [Powell] was not happy about the situation."

Under the terms of the contract, the city pays BFI $5.86 for each container it empties for the city. The city is responsible for more than 2,800 commercial containers.

The city charges BFI $13 a ton to dump city garbage in the city landfill.

But when BFI enters the landfill, the city requires the firm to pay a $39.50 tipping fee for each ton of garbage it dumps.

BFI is later reimbursed via credits of $26.50 cents a ton after a series of calculations are made to determine the number of tons BFI collected from city containers.

BFI is also under contract to pickup containers at private companies.

"The people at the landfill didn't understand that the credit meant reduced revenue," Pedersen said.

The city anticipated $11.6 million in revenue for fiscal year 1993-94. Officials had projected $11.9 million for fiscal year 1992-93 and $15.2 in 1991-92.

More than half of the revenue for the solid-waste fund — $7 million — is generated by the tipping fee. The remainder is generated by investment income, the sale of recycled goods, the disposal of dead animals and trailer rentals.

Besides reducing services, another solution to the $2-million problem could involve the transfer of money from other sources. Whatever the city decides to do, it is likely taxpayers ultimately will pay either in reduced services or higher taxes.

Dec 23, 1993 The News + Observer

Garbage fund in the dumps by $1.8 million

The city may have to raise taxes or impose a collection fee to cover a mistake in reporting landfill revenues.

BY TIM VERCELLOTTI
STAFF WRITER

DURHAM — A major accounting foul-up will leave the city short $1.8 million in its garbage management fund by the end of the fiscal year, which could mean higher taxes or a collection fee for residents.

Red-faced city officials discovered the mistake while auditing the city's books for the 1992-93 fiscal year, which ended June 30. The audit is due to be presented to the City Council in January.

City Manager Orville Powell is scheduled to brief the council on the problem, and possible solutions, Jan. 6 at the next meeting of the council's Finance Committee.

"The problem was caused by a failure of communication between the Sanitation Department and the Finance Department," Powell said. "We're suggesting corrective action be taken in the next budget."

Powell and City Finance Director John Pedersen Jr. would not say what solutions they'll recommend to the council. The council must adopt a 1994-95 budget by July 1.

But Pedersen acknowledged Tuesday that the options include a tax increase, a garbage fee, an increase in the dumping fee at the city landfill and cuts in the Sanitation Department.

The city property tax rate would have to increase by nearly 3 cents per $100 of property value to cover the shortfall. Each penny on the tax rate, which is now 67.1 cents, generates about $625,000 in revenue.

The City Council has periodically debated a fee for garbage collection, which is now financed primarily through tax revenues. The most recent proposal came in 1992, but council members rejected it because they thought it was regressive.

Mayor Sylvia Kerckhoff said she's not eager to impose a garbage collection fee, but, "I'd certainly do a user fee before I'd raise taxes."

The accounting error came in tracking credits granted to Browning-Ferris Industries of the South Atlantic Inc., which holds a city contract to collect garbage from businesses in Durham.

The company is scheduled to receive about $1.23 million from the city for commercial garbage collection during the 1993-94 fiscal year. Under a complex arrangement with the city, BFI also receives a credit on tipping fees the company pays at the landfill.

Outside haulers must pay a fee of $39.50 a ton to dump garbage at the landfill off Club Boulevard. BFI receives a $26.50 credit and pays only $13 a ton.

City sanitation officials stopped reporting the credit to the city Finance Department in January 1992, about 11 months into BFI's five-year contract with the city. The error caused city officials to overestimate revenues in the city's solid waste fund, budgeted this year at $11.78 million.

The mistake went undetected when the city audited its 1991-92 books last year, and continued into the current budget.

As a result, the discrepancy is expected to swell to $1.8 million by the end of the current fiscal year. "We based projections on a figure we thought was accurate, and we compounded the problem," Powell said.

Costs of garbage collection up, revenues off — someone will pay

BY TIM VERCELLOTTI
STAFF WRITER

DURHAM — One way or another, city residents and businesses are likely to pay more to get rid of garbage in the fiscal year starting July 1.

Faced with growing costs and shrinking revenue at the city's landfill, the City Council heard options Monday for raising money to pay for garbage collection and disposal.

The choices included increasing the tipping fee at the landfill, boosting the property tax rate or imposing a monthly fee for collection of garbage and recyclable items.

Council member Floyd McKissick Jr. added a fourth option — seeking state legislation that would allow Durham and other local governments to impose a 1-cent gasoline tax, which could generate $40 million statewide.

The city could press its legislative delegation to introduce a bill during the General Assembly's short session, slated to begin in May.

"People are used to fuel prices being volatile, going up or down a cent or two," McKissick said. "It probably wouldn't bother people too much."

City Manager Orville Powell said state lawmakers have resisted such requests in the past.

"It'd be difficult to get the General Assembly to do it," he said. "But we could try."

Council members made no decisions at the five-hour meeting, but were adamant that they will not consider a fee to collect trash and recyclables.

A proposed garbage collection fee went down in flames in 1992 after residents complained that the levy would be regressive. City administrators Monday proposed fees totaling $8.58 per month coupled with a property tax cut, but council members said the proposal would hurt poor residents.

"I think it's a bad idea," council member Diane Wright said.

City administrators will return with more detailed recommendations this spring, before the council tackles the 1994-95 budget. Whatever route council members take, they admitted they'll face a hard sell with city residents.

"We have to communicate to the public how exorbitant these costs are," council member Sandy Ogburn said.

The city is facing two dilemmas. Costs will rise next year with the opening of an $11.58 million transfer station where the city and private haulers will dump garbage onto railroad cars for shipment to Montgomery County. Revenue from the $39.50-per-ton tipping fee, meanwhile, is expected to drop as more people recycle.

The cost of garbage collection and disposal is projected to jump from $9.8 million this year to $15.8 million in the 1998-99 fiscal year. Revenue from the tipping fee is expected to decrease from $7.37 million this year to $6.4 million in 1998-99.

Tax dollars already make up the difference. If the city relied only on the property tax to fill the growing gap, the council would have to add 3.12 cents to the tax

SEE GARBAGE, PAGE 6B

The News & Observer Jan 24, 1994

GARBAGE

CONTINUED FROM PAGE 1B

rate in fiscal year 1994-95, and a total of 8.07 cents by 1998-99. The current rate is 67.1 cents per $100 valuation.

If the council left the tax rate as is, the $39.50-per-ton tipping fee would have to swell to $53.25 per ton next year, and $90.35 per ton by 1998-99. But city officials warned that such a dramatic increase could backfire and send private haulers to other landfills that have cheaper rates.

"I don't think, realistically, that coming in with a greatly increased tipping fee is going to work," city Finance Director John Pedersen Jr. said.

In a related matter, Pedersen recommended the city borrow $1.2 million from its water and sewer fund to close a deficit in the solid waste management account.

An accounting error created the shortfall, and Pedersen previously had recommended using about $365,000 from the account's fund balance to shrink the figure to $900,000.

He suggested Monday that the city borrow to cover the entire deficit and leave the fund balance intact. The council did not act on the proposal.

TRENDS

recycling, international, landfills, composting, collection and legislation

Study Provides Evidence Of Lower Cost Recycling

The environmental benefits of recycling are obvious: retrieving recyclable materials from the waste stream saves landfill space and conserves valuable natural resources. But a recent study prepared by Seattle-based economic consultants Sound Resource Management Group Inc. for the Clean Washington Center (CWC) shows that recycling can also be an economic alternative to waste disposal.

Traditionally, recycling programs have been hindered by the fact that they can cost more than disposal. The CWC, a division of Washington's Department of Trade and Economic Development, strives to make the recycled material cost competitive and hopes that its report will dispel the belief that recycling is too expensive.

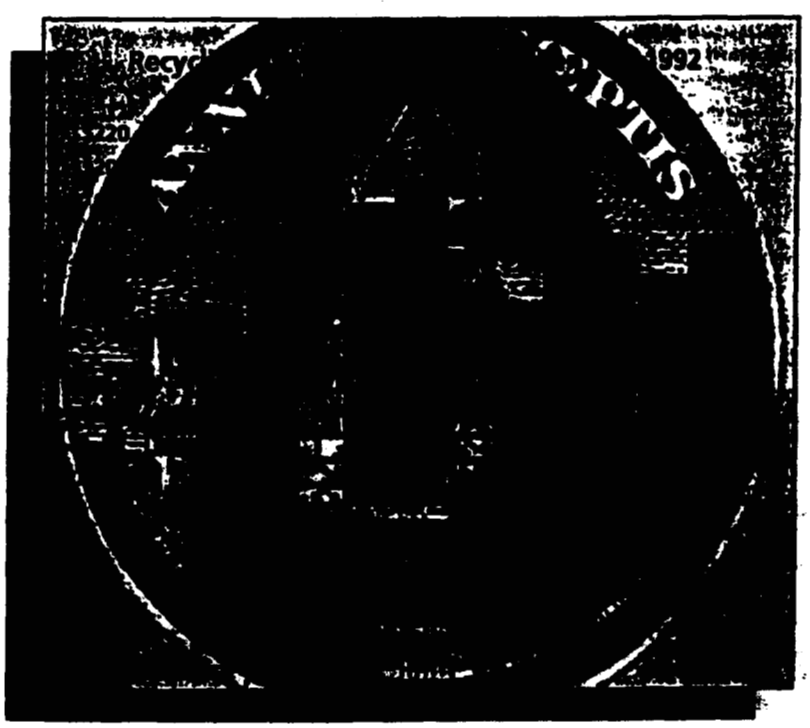
The CWC report, "The Economics of Recycling and Recycled Materials," compares the 1992 costs for residential curbside recycling and disposal systems in four diverse Washington cities: Seattle, Spokane, Bellingham and Vancouver.

Five recyclable materials were studied — old newspapers (ONP), glass containers (cullet), plastic milk jugs (HDPE), plastic soda bottles (PET) and yard waste. The report concludes that in six high value markets, the recycled materials can be a cost-saving substitute for virgin materials.

The report examines recycling costs and the use of recycled materials from two points of view, the city's and the manufacturer's. "The city's perspective is important because this is who identifies which wastes to recycle and determines how much to charge its citizens. The manufacturer's perspective is critical because it is this recycled material customer who chooses whether or not to use recycled materials in their product and also determines the price they will pay for it," said Susan Bogert, the CWC's policy research manager.

The report also finds that the average net cost per ton for recycling in 1992 was lower than disposal in all four cities. Disposal costs exceeded recycling costs by a range from $13 per ton in Spokane to $65 per ton in Bellingham, with Vancouver and Seattle in between at $25 and $47 per ton, respectively (see chart).

Net cost per ton was determined by adding collection/overhead expenses and processing fees (for recycling) or transfer and disposal costs (for disposal), then subtracting the amount of revenue earned from sales of recyclable materials.



Each city varied tremendously in recycling savvy, explained Bogert. Seattle, for example, "spent a lot of time tracking and understanding their costs. They understood their system well and were very conscientious in contract negotiations," she said. As a result, Seattle has the lowest cost per ton among the four cities for recycling and disposal.

Bogert notes that Seattle and Bellingham have been recycling longer than the other cities, which might account for their lower recycling costs. Seattle began its curbside recycling program five years ago; Bellingham started its curbside recycling program in 1989, replacing a local nonprofit organization that had been collecting recyclables in several neighborhoods since the beginning of the 1980s. "People in Bellingham and Seattle have become more accustomed to thinking in the terms of recycling waste," said Bogert.

Only Spokane's system is completely city-run. The other cities contract collection. Spokane reported collection costs of $199 per ton but incurred no processing fee because the driver separates the recyclables into seven bins in the truck. The materials are sold to a private recycler. Vancouver also avoided processing fees by selling recyclables off the truck for a flat fee of $6 per ton.

The density of recyclable materials can increase collection costs dramatically, according to the study. Bogert notes that increasing density of lightweight plastic and aluminum containers, for instance, can make collecting recyclables more efficient and cost effective.

The study has sparked interest in further educating the public. "We wanted to focus on what recycling is really costing and even to inspire debate on the topic — as long as people are talking about and using the information," Bogert said.

For a copy of the report, call the CWC's report order line at (206) 587-5520.

— Michelle Roberts

Problem Solvers Grapple With C&D Waste

European initiatives aimed at reducing consumer packaging waste recently have received much attention. The landslides of garbage pictured in popular magazines and TV broadcasts display packaging as our foremost waste dilemma. The perception is that with enthusiastic reduction measures — prevention and all-out recycling — our disposal problems essentially would be solved.

But those responsible for waste management know that consumer products packaging makes up a relatively small portion of the waste avalanche. Packaging in Europe is estimated to account for approximately 20 percent of the household waste tonnage, which is only about 4 percent of the entire solid waste stream by weight (see figure).

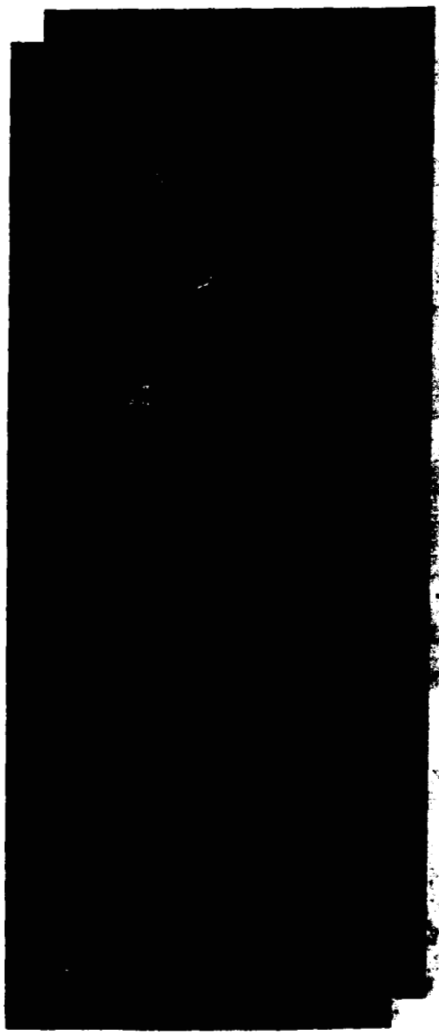
Over and above the discards in people's trash cans, there are other types of waste produced in massive quantities. In the European Community, the largest fraction is agricultural waste, contributing over 50 percent to the total tonnages. Other major contributors are mining waste, power plant residue and sewage sludge. Next in line is construction and demolition (C&D) material, which makes up about 7.5 percent of all solid waste.

In West Germany, C&D waste amounts to nearly half of the solid waste remaining after agricultural wastes are subtracted. By comparison, the municipal solid waste (MSW) collected from both households and offices is less than a tenth of this total by weight.

The standard German definition of C&D waste includes three categories: debris which is largely mineral in content and results from building demolition; soil and rock from excavation activities; and solid materials of mineral content that are generated by work on streets, sidewalks and bridges.

The trend in Germany is to charge different disposal fees depending on the C&D category. This encourages sorting into reusable, hazardous and nonhazardous components. Excavation material is frequently reused but, even if not, it is suited for disposal in landfills. The same is true for demolition rubble, particularly from buildings predating 1930, which consists primarily of wood, iron and stone or brick. Because of their relatively homogeneous composition, C&D materials are increasingly sent to monofills, constructed at a lower cost than MSW landfills.

In *Umdenken in der Abfallwirtschaft* (*Rethinking Waste Management*), the authors predict that, in the future, disposal fees for nonhazardous C&D waste will lead to waste prevention and conservation of raw materials in Germany by making renovation more cost effective than demolition and new construction. Eventually, they claim, buildings will be designed for longer use and easier separation into their components once demolition becomes inevitable.



The German trade association representing the private waste industry, BDE (Bundesverband der Deutschen Entsorgungswirtschaft), judges that 90 percent of demolition material is reusable. Germany already has 220 stationary C&D debris recycling plants, and incentives are expected to boost reprocessing/reuse to almost two-thirds by the end of this decade.

The Netherlands is the acknowledged leader in C&D recycling. With more than 15 million people and a shortage of mineral deposits, this small country has compelling reasons to avoid waste. Substantial amounts of C&D waste (reported as nearly three-quarters in *Public Innovation Abroad* and as 65 percent in the *Warmer Bulletin*) are being recycled in a joint effort of the government and the road building industry. Instead of importing the road stone and landfilling the C&D waste, the Dutch recycle asphalt on site and granulate the demolition waste for use as a road base.

A Dutch plant, in Alphen aan den Rijn, processes as much as 80,000 metric tons of wood, stone, brick and reinforced concrete annually. The wood is chipped for composting, and the stones are then crushed, as well as the concrete, from which ferrous metals are magnetically removed.

Land-poor countries are not the only ones looking for ways to keep C&D waste out of landfills. In Canada, the city of Brampton, Ontario, is also on the road to C&D recycling. Roof shingles are ground and mixed with hot asphalt to create a granulated bituminous shingle material for road resurfacing. Up to 11 percent shingles, by volume, can be added to the asphalt. Anticipated benefits are a more resilient road surface, plus, if the highway test section proves successful, the opportunity to recycle up to 100,000 tons of shingles a year province-wide.

— Ann Kulik
HDR Engineering, Inc.

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ENVIRONMENTAL GROUP AND LEADING ORGANIZATIONS CREATE TASK FORCE
Seek to Build Environmental Criteria into Paper Purchasing

(18 August 1993 -- New York) Seven organizations have announced the creation of a task force that will develop recommendations for increasing the use of environmentally preferable paper and paperboard products in the United States.

Organized by the Environmental Defense Fund (EDF), the Paper Task Force includes Duke University, Johnson & Johnson, McDonald's, NationsBank Corporation, The Prudential Insurance Company of America, and Time Inc. Collectively, these organizations annually purchase more than $1 billion of paper products in three major areas: business printing and writing papers, publications, and packaging.

Paper products make up one-third of municipal solid waste. The full cycle of pulp and paper production also affects natural resources, energy use, and the quality of air and water.

"EDF is working with leaders in their fields; together we may be able to change the way paper is produced, purchased, and used in the United States," said Fred Krupp, EDF's executive director. "Through a market-based approach, the task force will develop recommendations to better integrate environmental considerations into paper purchasing."

The task force's two goals are to expand its members' use of environmentally preferable paper products and to design a purchasing model applicable to a broad range of institutions. The task force's findings will be published in a public report to be issued in 12 to 18 months.

As a first step, the task force members will assess the performance needs and purchasing specifications of the paper they use. Next, the task force will comprehensively consider scientific and economic information on the environmental effects of paper production, use, recycling, and disposal. The analysis will consider recycled and virgin papers, and paper produced by various pulping and bleaching technologies. The results of the analysis will drive the final recommendations.

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The task force will actively seek the views of experts in the pulp and paper industry, the environmental and economic communities, and university research institutions. Task force members also will work closely with their paper suppliers in this process.

"NationsBank is proud to participate in this project that we hope will produce ideas for more responsible use of paper and the natural resources involved in its production," said Timothy E. Jarman, corporate services executive for NationsBank. "We believe the incorporation of environmental considerations along with cost, functionality, and availability in paper purchasing can become a win-win situation for all involved."

"Our experience with recycling has shown us that environmentally sensitive decisions can make good business sense when both paper purchasers and producers are involved," said Edward D. Zinbarg, executive vice president of The Prudential.

"The Paper Task Force's evaluation process and forthcoming recommendations can only serve to accelerate our corporate packaging improvement efforts," said Paul F. Boorujy, vice president, corporate purchasing of Johnson & Johnson.

"We're quite encouraged by the fact that such a diverse group of companies can work so closely with an environmental group like EDF to address the environmental challenges that confront all of us," said Donald J. Barr, executive vice president of Time Inc.

Signed agreements creating the task force establish a schedule and a specific scope of work. Included are several provisions to preserve the independence and integrity of each organization. For example, each organization will be responsible for its own expenses and will pursue business and advocacy activities as it sees fit. EDF will receive no financial or other support from any task force member at any time.

Major support for EDF's role in the task force is provided by the Heinz Family Foundation. "We are proud to support this innovative effort to demonstrate that economic and environmental needs can be aligned and made mutually supportive," said Teresa Heinz, chairman of the Heinz Family Foundation and the Howard Heinz Endowment. "We commend the task force's plan to build environmental concerns into paper purchasing decisions."

"Not only is Duke University interested in creating a model for other educational institutions, but this task force provides wonderful educational opportunities for students in our new School of the Environment," said Norman L. Christensen, dean of the school at Duke.

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Copies of the memorandum of agreement that establishes the task force are available upon request.